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Evaluation of Emission Control Systems on a Catalytic Woodstove as Used in Whitehorse

(This work was supported by the Federal Panel on Energy R & D [PERD])

Final Report

by

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The participants in the Whitehorse Efficient Woodheat Demonstration study, who allowed us continued access to their homes to evaluate woodstove performance.

Executive Summary

This report represents a follow-up study of the performance of the replacement catalytic combustors installed in Blaze King "King" (Model KEJ 1101) woodstoves used during the 1987-88 heating season in homes located in Whitehorse identified as W07 and W11. The purpose of this study is to: (1) evaluate the integrity of key components of the emission control systems of the two Blaze King "King" catalytic woodstoves in homes W07 and W11; and (2) to assess the emission reduction performance of the catalytic combustors in the stoves under laboratory conditions.

The study was divided into four tasks.

1. A thorough inspection of the emission control systems of the Blaze King "King" woodstoves in homes W07 and W11 in October 1988. At the completion of the inspections, the installed Corning "Long Life" catalysts were removed and replaced with new Corning "Long Life" combustors. To quantify the amount of catalyst bypass leakage, a testing instrument was used to measure flow rates at various draft levels.

2. A detailed interview of the residents in homes W07 and W11 was conducted to determine how their woodstoves were fueled and operated during the 1987-88 heating season.

3. Catalytic combustors removed from homes W07 and W11 were evaluated using EPA woodstove emission testing Methods 28 and 5G (dilution tunnel).

4. Catalytic combustor performance was also evaluated using a catalytic combustor bench tester developed under the sponsorship of the Northeast Cooperative Woodstove Study.

The stove inspections revealed continuing deterioration of key components of the emission control system in the woodstove in home W07. Visual combustor damage, i.e., significant peeling of the wash coat was also observed. The homeowner was not aware of the problems observed in the inspection.

Except for a weld crack in the secondary air manifold, the woodstove in home W11 was in good condition. No visible damage to the catalytic combustor in this stove was observed.

Two leak tests were conducted in each stove, one with the existing bypass damper gasket and one with a new bypass damper gasket. The replacement of the bypass damper gasket reduced the average leak rate by 28% (home W07) and 42% (W11). However, "after maintenance" leak rates were significantly higher than for a similar stove located in Portland, Oregon. The reason for the higher leak rates for the Whitehorse stoves could not be determined.

Six Method 5G/28 test runs were completed, four with the combustor from home W07 and two with the combustor from home W11. The EPA particulate emission weighted average for the four runs with combustor W07 was 14.1 grams/hour. The mean emission rate for the two test runs conducted with the combustor from home W11 was 6.2 grams/hour. The EPA certification value for this stove is 1.9 grams/hour.

The bench tester indicated significant differences in the percentage of propane conversion at 316°C (600°F) between new (unused) combustors and the combustors used in homes W07 and W11 during the 1986-87 heating season (Panasonic combustors), and the 1987-88 heating season (Corning "Long Life"). However, the measurement of propane conversion could not determine significant performance differences between used combustors that demonstrated elevated particulate emission rates and a combustor that showed little or no emission reduction performance degradation based on EPA Method 5G/28 testing.

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1.0 Introduction

During the 1986-1987 heating season, a study was conducted in Whitehorse, Yukon Territory, Canada, to evaluate the emission and efficiency performance of several new woodheat technologies.[1] Oregon-certified Blaze King "King" (Model KEJ 1101) woodstoves were installed in two residences in Whitehorse identified as homes W07 and W11. At the end of the 1986-87 heating season, the emission control system of each woodstove was inspected and the catalytic combustors (Panasonic "Honeycomb") were removed and replaced with Corning "Long Life" combustors. The woodstove originally installed in home W07 was used during the 1987-88 heating season with no changes to the emission control system. The woodstove originally installed in home W11 was removed prior to the start of the 1987-88 heating season and replaced with a new Blaze King "King" due to the warpage of the combustor seat. The replacement stove in home W11 was used throughout the 1987-88 heating season.

A second inspection of the woodstoves in homes W07 and W11 was conducted at the end of the 1987-88 heating season. Catalytic combustors used during the 1987-88 heating season (Corning "Long Life") were also removed for further emission performance evaluation.

This report represents a follow-up study of the performance of the replacement catalytic combustors in the Blaze King "King" woodstoves used during the 1987-88 Whitehorse heating season in homes W07 and W11. The purpose of this study is to: (1) evaluate the integrity of key components of the emission control systems of the two Blaze King "King" catalytic woodstoves in homes W07 and W11; and (2) to assess the emission reduction performance of the catalytic combustors in the stoves under laboratory test conditions.

2.0 Technical Discussion

2.1 Technical Approach

This study was divided into the following four tasks:

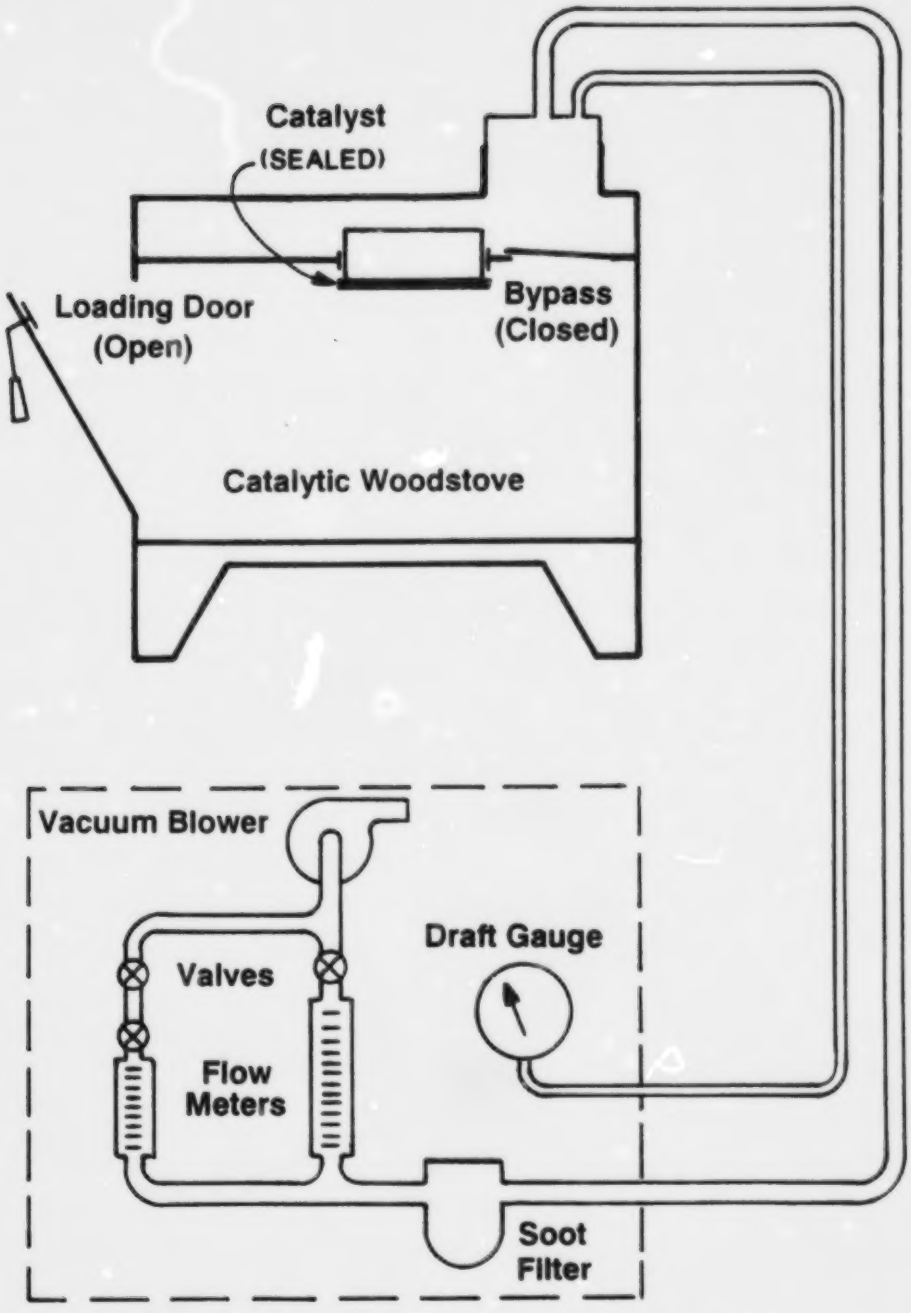
Task A – Stove Inspection and Leak Checks

A thorough inspection of the emission control systems of the Blaze King "King" woodstoves in homes W07 and W11 in Whitehorse, Yukon Territory, was conducted in October 1988. This inspection included the catalyst; the bypass door mechanism; the thermostat control system; the primary, secondary, and tertiary air supply systems; and all gaskets. This inspection was similar to the inspection conducted at the end of the Whitehorse Efficient Woodheat Demonstration study.[1] At the completion of the stove inspections, the catalysts were removed and replaced with Corning "Long Life" combustors. The bypass damper door gaskets were also replaced. To quantify the amount of catalyst bypass leakage while the bypass damper was closed, a testing instrument was used to measure flow rates at various draft levels. Dubbed the Leak Testing Device (LTD), it was used to test the catalytic stoves during the inspection. A schematic of the LTD is shown in Figure 2-1.

The LTD uses a blower to induce a slight vacuum, simulating typical draft conditions, at the flue collar of the stove. The catalytic combustor is sealed off. The flow rate of air leaking around the combustor at various vacuum (draft) levels is measured using a rotameter. A Magnehelic is used to measure draft levels. Rotameters are calibrated against reference dry gas meters to assure their accuracy.

Pressure-sensitive duct tape was used to seal off the inlet face of the catalytic combustors during testing. Tape was also used to seal seams at the flue collar, thermometer holes, bypass rods, etc. The tape provided a satisfactory seal with the low levels of vacuum encountered.

The measurements obtained with the LTD represent the maximum probable bypass leakage at each specified draft level. In the actual burning of a woodstove, the bypass leak rates would probably be lower simply because the combustor is not completely sealed off. Another unknown factor is the influence of high temperatures on the bypass seal and leak rates. All data obtained with the LTD were at ambient room temperature, while an operating stove would have the bypass sealing at a temperature several hundred degrees higher. Replacement of the bypass damper gasket allowed a before-and-after leak rate comparison. Data



LEAK-TESTING DEVICE SCHEMATIC
FIGURE 2.1

derived from the tests were compared to leak test data generated from a report regarding stove performance for a Blaze King "King" stove in the Portland area.[2]

Task B – Home Interviews - Stove/Wood Use Estimates

Detailed interviews of the residents in homes W07 and W11 were conducted to determine how their stoves were fueled and operated during the 1978-88 heating season. The interviews focused on extracting information on the homeowner's perception as to the performance of the catalyst over the heating season. Using the information collected in the interviews, 1987-88 heating season weather data, and stove performance data collected during the Whitehorse Efficient Woodheat Demonstration Study[1], an estimate of the total hours the stove was operational during the 1987-88 heating season was calculated. An estimate of the total amount of wood used by specie is also included in the analysis.

Task C – Laboratory Emission Tests

The catalysts removed from the woodstoves in homes W07 and W11 were tested at OMNI's laboratory in Beaverton, Oregon. Emission performance was evaluated using EPA woodstove emission testing methods 28 and 5G (dilution tunnel).[3] The objective of the laboratory emission tests is to evaluate the performance of the Corning "Long Life" catalysts under standardized woodstove emission certification procedures.

Task D – Catalytic Combustor Bench Tests

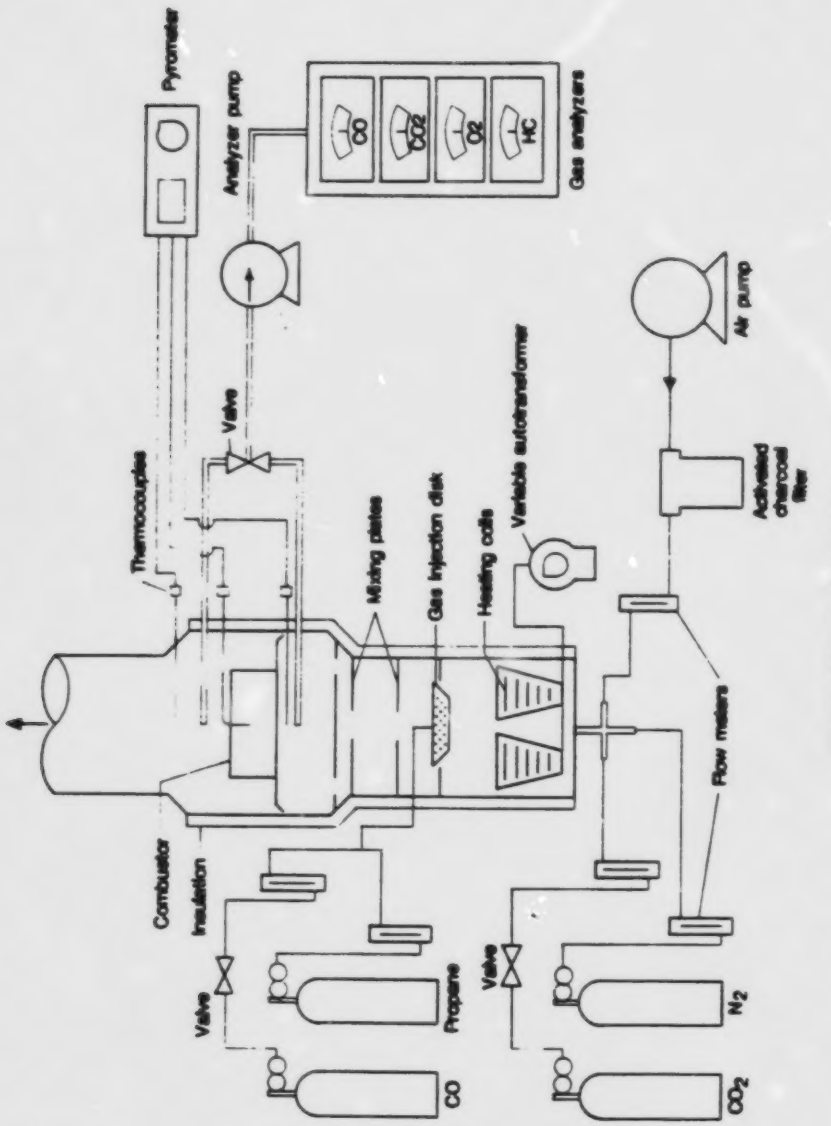
Catalyst performance was independently determined with the recently-developed catalytic combustor bench tester developed under the sponsorship of the Northeast Cooperative Woodstove Study.[4] This bench test method provides a means of evaluating the performance of catalytic combustors used in woodstove appliances. The method measures carbon monoxide and hydrocarbon conversion as well as "light-off" temperatures by exposing the combustor to atmospheres which simulate those encountered during actual use.

A catalytic combustor is tested by exposing it to the desired gas mixture and monitoring the temperature and gas conversion which take place as the combustor is heated. A blend of cylinder gases and clean ambient air provide a consistent fuel supply to the combustor, allowing catalyst performance evaluation under stable conditions. A consistent combustor fuel supply is not generally found with woodstoves, which exhibit the variations and cycling inherent with a batch-fueled device.

This bench test procedure uses the whole catalytic combustor and is non-destructive, allowing tested combustors to be used in a woodstove.

Figure 2-2 shows a schematic of the woodstove catalytic combustor bench tester. Descriptions of the apparatus are as follows:

1. Bench test chamber	Combustor cassette, several configurations of which are utilized to accommodate various combustor geometries (round, oval, and rectangular).
2. Heating elements	1000-watt cone-type elements (3).
3. Heater controllers	Variable voltage transformers (3).
4. Gas cylinders	Cylinders of nitrogen, carbon dioxide, carbon monoxide and propane, plus appropriate regulators, are required.
5. Air pump or blower	To provide 1.6 cubic feet ambient air per minute or more.
6. Air filter	Activated charcoal/glass wool filter to clean air supply.
7. Flow meters	Rotameters (5) of appropriate range with flow control valves.
8. Carbon monoxide detector	Carbon monoxide (CO) is measured with an Infrared Industries, Inc. infrared gas analyzer (Model 732) calibrated in the 0 to 2 percent (V/V) range. Instrument may also measure carbon dioxide (CO_2) and oxygen (O_2) gas components (optional).
9. Hydrocarbon detector	Total hydrocarbons (HC) are measured with a Sun Industries infrared hydrocarbon analyzer calibrated in the 0 to 0.5 percent (V/V) range (0 to 5,000 ppm). (A sample dilution system may be used if the HC analyzer has a range lower than the concentration of propane to be used for testing.)



BENCH TESTER SCHEMATIC
FIGURE 2.2

10. Thermocouples	Three type K thermocouples with appropriate display and/or recording instruments.

Catalytic combustors removed from both the 1986-87 and 1987-88 heating seasons from homes W07 and W11 were evaluated. To determine baseline conditions, new Corning "Long Life" and Panasonic "Honeycomb" combustors were evaluated with the combustor bench tester.

2.2 Results

2.2.1 Task 1 – Stove Inspection

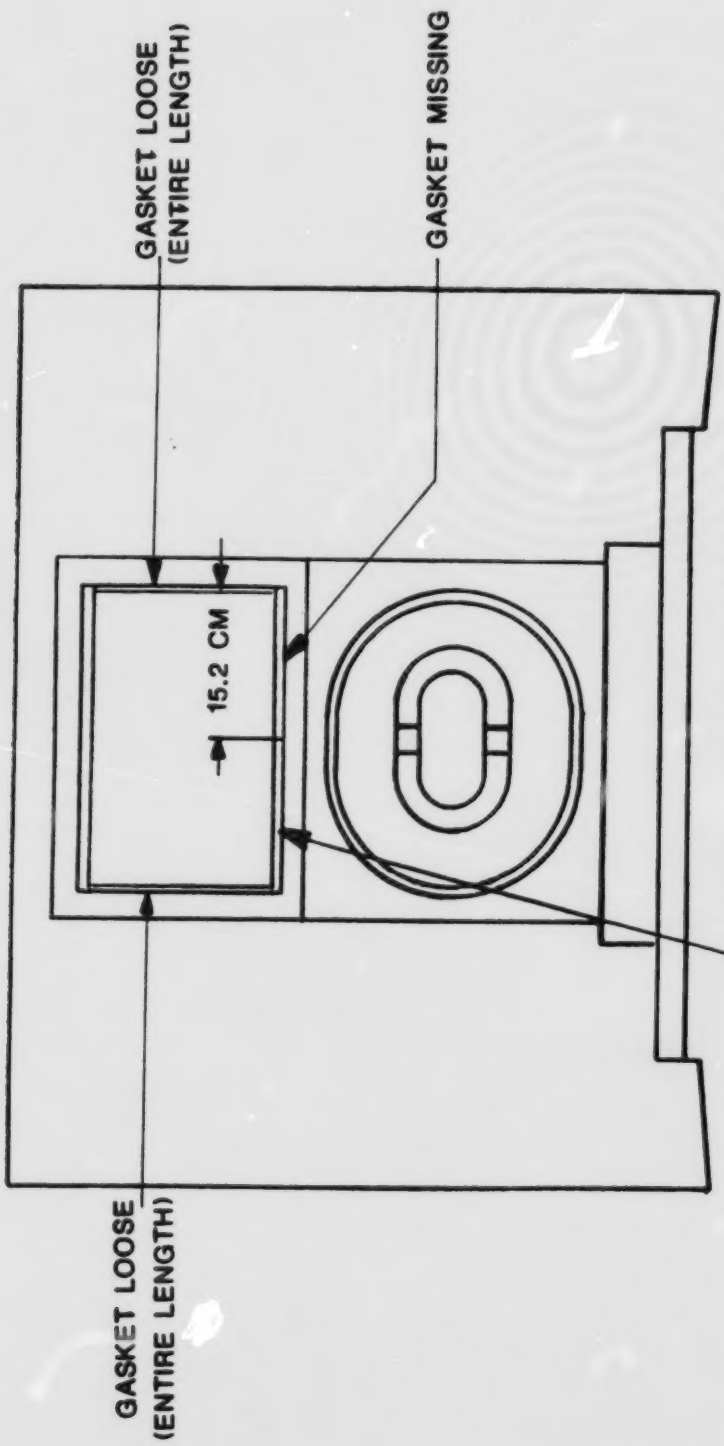
Home W07

An inspection of the Blaze King "King" (Model KEJ 1101 Serial No. KEJ 6110699) catalytic stove used in home W07 was conducted on October 18,1988. This was the same woodstove used in the Whitehorse Demonstration Study, and was originally installed in home W07 in January 1987. Assisting in the inspection was a representative from Griffith's Heating and Service Ltd. (installers of the stove). A detailed inspection of the entire emission control system was conducted which included the catalyst, the bypass damper mechanism, the thermostat control system, the primary, secondary, and tertiary air supply systems, and all gaskets.

After removal of the flue pipe, the bypass door assembly was inspected. Approximately 3.8 cm (1.5 in.) of creosote and ash had built up behind the bypass door. However, the creosote-like material did not appear to be interfering with the operation of the bypass door mechanism. The bypass damper was then carefully opened to inspect the condition of the gaskets used to form a seal around the door.

The inspection revealed that approximately 15.2 cm (6.0 inches) of the front edge of the gasket was missing. The remaining portion was very loose on the front edge. The gasket material on both sides of the bypass damper door mechanism was loose and partially twisted. Figure 2.3 shows the areas of loose and missing gasket material. Discussions with the homeowner indicated that the bypass damper door gasket had not been replaced since the stove had been installed in January 1987. The manufacturer recommends annual inspection of this gasket.

An inspection of the welds on the bypass damper door was also conducted. Two weld gaps, each approximately 0.238 cm ($^3/_{32}$ in.) in length, were observed. Figure 2.4 shows the location of the weld gaps. An



BY PASS DOOR GASKET-BLAZE KING'KING'-HOME W07
FIGURE 2.3

BY PASS DOOR ASSEMBLY -BLAZE KING 'KING' HOME W07

FIGURE 2.4

inspection of the gasket material in the vicinity of the weld gaps did not reveal any indication of the escape of combustion gases through the weld gaps.

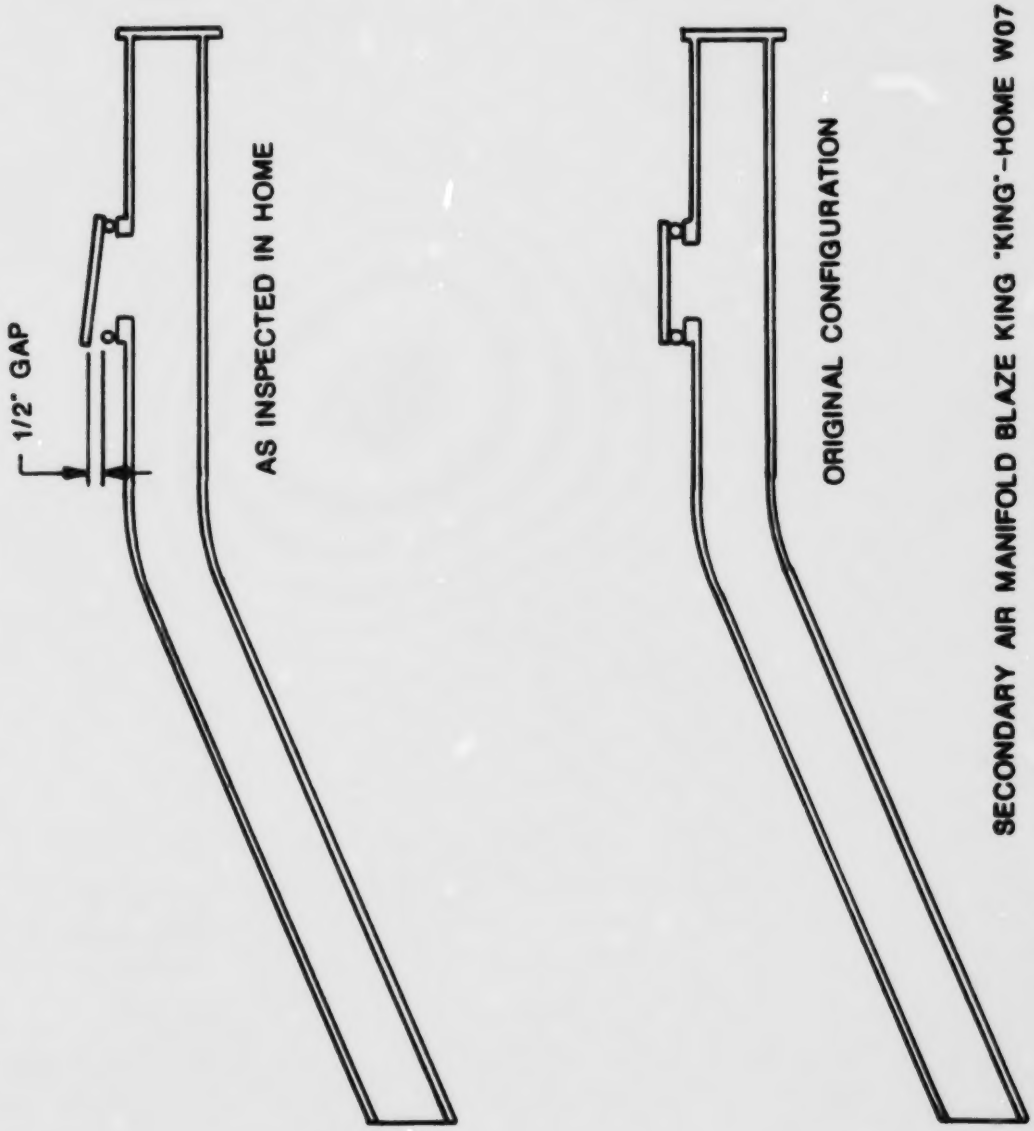
The secondary air tube assembly was carefully removed so that a light leak check of the Interam™ gasket around the catalyst could be conducted. Upon removal of the secondary air assembly, it was discovered that one of the welds holding the top plate was cracked. The plate was bent up at a 45° angle, creating an approximately 1.3 cm (0.5 in.) gap (refer to Figure 2.5). Due to the design of the Blaze King "King", it was possible only to light leak check the back edge (nearest the combustor access flap) of the gasket around the catalytic combustor. Using a 250-watt floodlight, no light leakage was observed around the gasket. However, approximately 20% of the combustor cells appeared to be blocked with light gray ash material.

The combustor (Corning "Long Life") was carefully removed to observe the condition of the Interam™ gasket around the front and sides of the catalyst. There appeared to be no gaps in the combustor gasket. However, the wash coat on the combustor was peeling in several locations in the upper one-third of the combustor. According to a trouble-shooting guide produced by the Corning Glass Works, catalyst peeling can be caused by "extreme temperatures (above 1000°C or 1800°F). Overfiring and flame impingement are primary causes."[5] The combustor seat was also warped in several locations and what appeared to be thermal stress cracks were observed throughout the combustor seat (refer to Figure 2.6).

The thermostat assembly was removed from the stove and inspected. It was discovered that a set screw which determines the amount of tension on the bimetallic thermostat coil was improperly set according to drawings approved as part of the Oregon stove certification process. As shown in Figure 2.5, the set screw should be 180° from the stop (View CC) when the top surface of the air intake flapper is flush with the thermostat housing (View AA). In fact, the set screw was approximately 80° from the "stop" position when the air intake flapper was flush with the top of the thermostat housing. As shown in View CC of Figure 2.7, the effect of this improper screw set point was to allow a higher heat output than could be achieved under certification specifications.

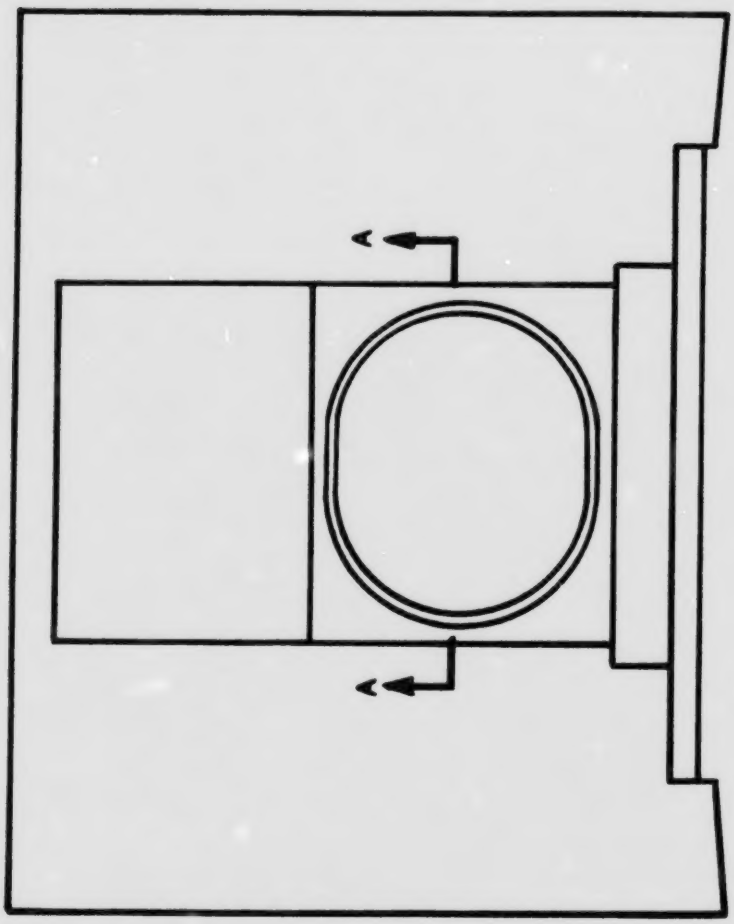
Home W11

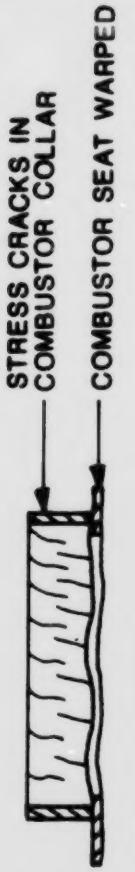
The Blaze King "King" (Model KEJ 1101 Serial No. KEJ1100301) woodstove inspected in home W11 was installed in September 1987. This stove replaced the stove used during the Whitehorse Woodheat Demonstration due to problems with warping of the combustor seat. As in the case with the woodstove in home W07, a detailed inspection of the entire emission control system was conducted on October 18, 1988.



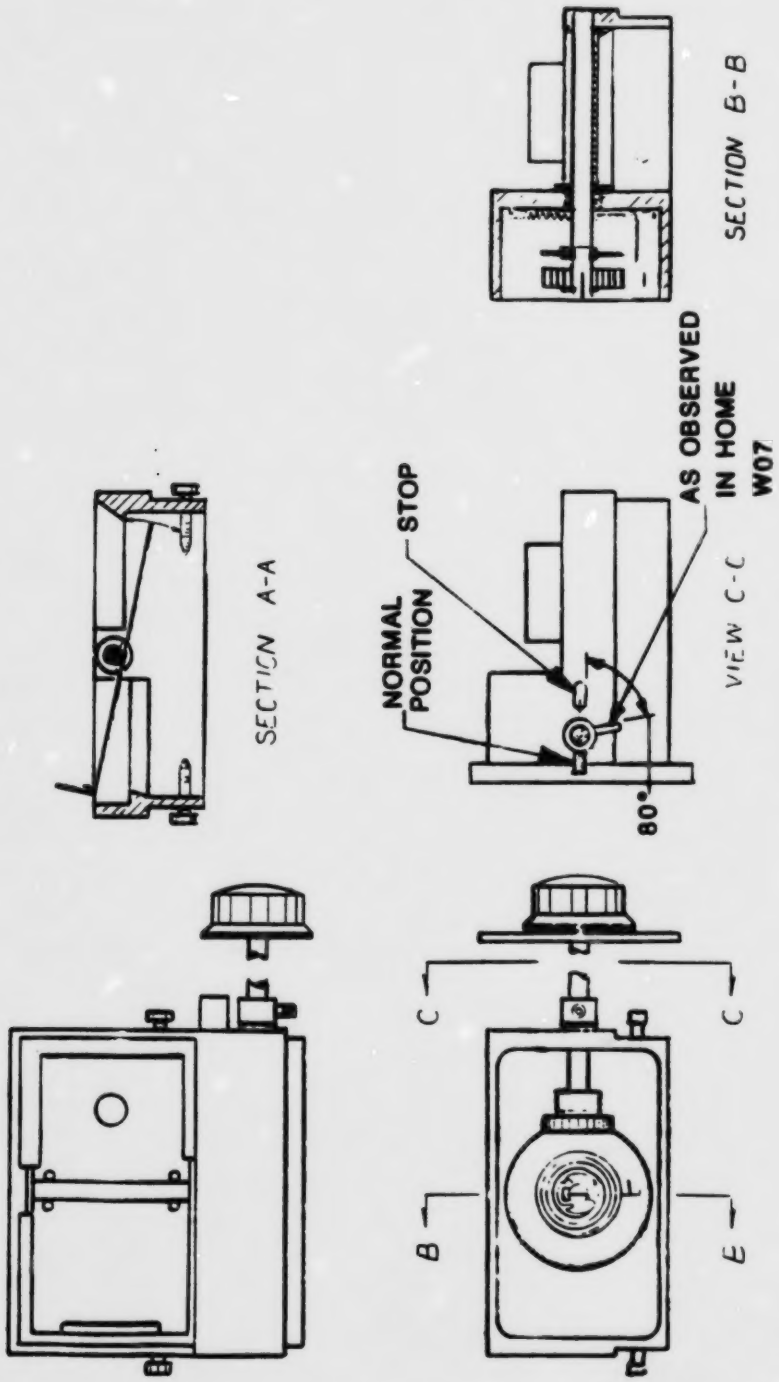
SECONDARY AIR MANIFOLD BLAZE KING "KING"-HOME W07

FIGURE 2.5





CATALYTIC COMBUSTOR SEAT-BLAZE KING 'KING'-HOME W07
FIGURE 2.6



STOVE THERMOSTAT ASSEMBLY – HOME W07
FIGURE 2.7

The inspection revealed only one potentially significant problem. As shown in Figure 2.8, the weld holding the upper plate of the secondary air manifold was cracked at the same location as discovered in the stove in home W07. However, the plate was not warped. No other defects were uncovered in the inspection. The thermostat set screw was properly set according to Oregon emission certification drawings. The bypass damper gasket was in good condition, i.e., no loose or missing pieces. The catalytic combustor (Corning "Long Life") showed no visual signs of overfiring, e.g., wash coat peeling, thermal stress cracks. The fuel door and combustor gaskets were in good condition. There were no weld gaps in the bypass damper door assembly.

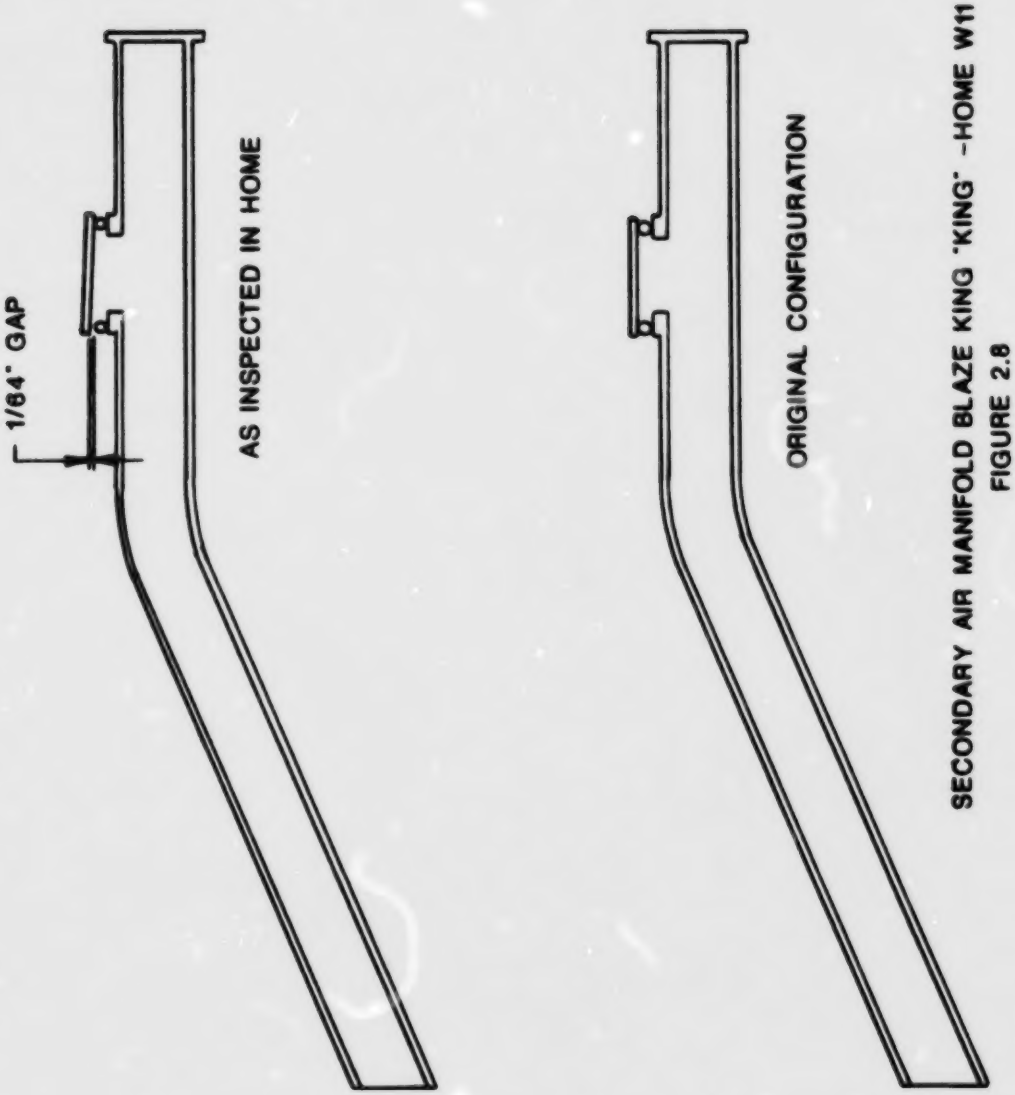
2.2.2 Task A – Leak Checks: Home W07 and Home W11

Two leak tests were conducted in each stove, one with the existing bypass door gasket and one with a new bypass door gasket. In each test, the fueling door was open, the inlet side of the catalyst was completely sealed, and the bypass door was closed. The results of these tests are shown in Tables 2.1 and 2.2. For purposes of comparison, the data from a similar leak test conducted on a Blaze King "King" in Portland, Oregon is shown in Table 2.3. From the data shown, the replacement of the bypass door gasket reduced the average leak rate (between 0.25 to 1.27 millimeters water) by approximately 28% (Home W07) and 42% (Home W11). However, the "after maintenance" leak rates in both of these stoves are significantly higher than the "after maintenance" measured leak rates in home P02. There appeared to be no visually obvious air leak area in the Whitehorse stoves. Possibly, leaks in the heat exchanger welds or other inaccessible areas may have contributed to the difference in measured leak rates between the Whitehorse and Portland stoves. Caution should be used in the interpretation of this data since leak rate conditions under actual stove operation may be different than indicated by the data in Tables 2.1, 2.2, and 2.3.

2.2.3 Task B – Home Interviews and Stove/Wood Use

Upon completion of each stove inspection, each stove operator was asked a series of questions regarding their respective fueling and stove maintenance practices. The responses to the questionnaire are contained in Appendix 5.1. Information related to the identity of each stove operator has been deleted to protect the privacy of these individuals.

Each stove operator was asked to estimate how many cords of wood were used during the 1987-88 heating season and how frequently the stove was operated. The independent estimates of wood usage and hours of operation were determined by correlating wood used and stove operation time with heating degree data.[6]



SECONDARY AIR MANIFOLD BLAZE KING 'KING' -HOME W11
FIGURE 2.8

Table 2.1

Leak Test Results – Blaze King "King"
Home W07

Draft		Leakage Rate as Found		Leakage Rate After Stove Maintenance[c]	
in. H_2O	mm. H_2O	SCFH[a]	LPM[b]	SCFH[a]	LPM[b]
0.01	0.25	20.0	9.4	13.0	6.1
0.02	0.51	25.0	11.8	17.0	8.0
0.03	0.76	33.0	15.6	24.0	11.3
0.04	1.02	38.0	17.9	29.0	13.7
0.05	1.27	45.0	21.2	35.0	16.5

a. Standard Cubic Feet Per Hour
b. Liters Per Minute
c. After catalyst bypass door gasket replaced

Table 2.2

Leak Test Results – Blaze King "King"
Home W11

Draft		Leakage Rate as Found		Leakage Rate After Stove Maintenance[c]	
in. H_2O	mm. H_2O	SCFH[a]	LPM[b]	SCFH[a]	LPM[b]
0.01	0.25	35.0	16.5	17.0	8.0
0.02	0.51	45.0	21.2	25.0	11.8
0.03	0.76	60.0	28.3	33.0	15.6
0.04	1.02	70.0	33.0	43.0	20.3
0.05	1.27	80.0	37.7	53.0	25.0

a. Standard Cubic Feet Per Hour
b. Liters Per Minute
c. After catalyst bypass door gasket replaced

Table 2.3

Leak Test Results – Blaze King "King"
Home P02 – Portland, Oregon

Draft		Leakage Rate as Found		Leakage Rate After Stove Maintenance[c]	
in. H_2O	mm. H_2O	SCFH[a]	LPM[b]	SCFH[a]	LPM[b]
0.01	0.25	7.2	3.4	< 3.1	< 1.5
0.02	0.51	11.8	5.6	5.9	2.8
0.03	0.76	16.1	7.6	8.7	4.1
0.04	1.02	20.6	9.7	12.3	5.8
0.05	1.27	25.4	12.0	14.1	6.8

a. Standard Cubic Feet Per Hour
b. Liters Per Minute
c. After catalyst bypass door gasket replaced

Wood use and stove operation data collected during the 1986-87 heating season from homes W07 and W11 was correlated with the associated number of heating degree days (HDD) for each day wood use measurements were taken with an electronic scale used during the Whitehorse Woodheat Demonstration Study.[1] HDD/wood use data was divided into ten intervals: 1 to 5; 6 to 10; 11 to 15; 16 to 20; 21 to 25; 26 to 30; 31 to 35; 36 to 40; 41 to 45; and 46 to 50 HDD. Average wood use consumption factors (pounds) and stove use (hours) per HDD interval per home were derived. A computer program generated estimated wood consumption (pounds) and stove operation time (hours) per home for the 1987-88 heating season by applying the appropriate average wood consumption and hours of operation per HDD interval factors to each day in the 1987-88 heating season.

The estimated wood consumption data per home for the 1987-88 heating season was derived by the following equation:

$$\text{Cords} = \frac{\text{total lbs. of wood burned}^{a}}{(\text{lbs./cord})^{b,c}}$$

a. Corrected to 20 percent moisture content dry basis

b. Specie(s)-specific density factor data derived from "Fuelwood Facts," Extension Circular #1023 Oregon State University Extension Service, September 1980.

c. All specie(s)-specific density factors were based on 20 percent moisture content, dry basis.

The results of this analysis are presented in Table 2.4. The computer-generated estimate of wood used during the 1987-88 heating season in home W11 may be biased on the high side due to the fact that the replacement stove in this home had a properly set thermostat, resulting in relatively lower burn rates as compared to the 1986-87 heating season.

2.2.4 Task C – Laboratory Emission Tests

The catalytic combustors removed from homes W07 and W11 were tested in accordance with the Environmental Protection Agency (EPA) 40 CFR Part 60, Subpart AAA — Standard of Performance for Residential Wood Heaters, as promulgated on Friday, February 26, 1988, and the Oregon Department of Environmental Quality (DEQ) "Standard Method for Measuring the Emissions and Efficiency of Woodstoves," dated June 8, 1984. Emissions were measured using the EPA Methods 28 and 5G. The testing was performed October 27 through November 3, 1988, at the OMNI Solid Fuels Testing Laboratory in Beaverton, Oregon. Detailed test results are found in Appendix 5.2 of this report.

Table 2.4

"Actual" Versus Perceived Wood Usage
and Stove Operation Time – 1987-88 Heating Season

Home Location Code	Estimated Wood Usage Measure-ment (cords)	Stove Operator Estimate of Wood Consumption (cords)	Difference	Stove Operation Time (hours)
W07	10.9	10.0	0.9	5600
W11	7.9	4.0	3.9	4000

Six test runs were completed, four with the combustor from Home W07 and two with the combustor from Home W11. Efficiencies and particulate emissions were measured. A summary of the test results are shown in Table 2.5. The EPA particulate emissions weighted average for the four runs conducted with combustor W07 was 13.99 grams/hour. The Oregon DEQ particulate emissions weighted average was 14.07 grams/hour. The KEJ1101 stove was originally certified with an Oregon particulate emission weighted average of 1.6 grams/hour.

The above results indicate significant degradation in the Corning "Long Life" combustor from the woodstove in home W07 with little to no performance degradation shown with the combustor from home W11. These results are not unexpected, given the differences observed in the woodstove conditions in homes W07 and W11 as discussed in section 2.2.1.

2.2.5 Task D – Catalytic Combustor Bench Tests

The results of the catalytic combustor bench tester are shown in Table 2.6. At an in-catalyst temperature of 316°C (600°F), both new Corning "Long Life" and Panasonic "Honeycomb" combustors (Run V1 and 4B) demonstrated 100% conversion of carbon monoxide (CO). Propane conversion at this temperature was 90% and 75% respectively. The design of the combustor bench tester did not allow inlet catalyst temperatures (TC1) to exceed 371°C (700°F), so that the evaluation of propane conversion above the 371°C temperature limit could not be determined.

The percent of CO conversion at 316°C (600°F) for the combustors used in homes W07 and W11 during the 1986-87 heating season were 100% and 93% and for the 1987-88 heating season, were 65% and 100%, respectively.

Significant differences in the percentage of propane conversion at 316°C (600°F) were demonstrated between new (Runs V1 and4B) and used combustors (Runs 2, 3, 4, and 6). However, the measurement of propane conversion could not determine significant performance differences between used combustors that demonstrated elevated particulate emission rates based on EPA Method 5G/28 tests and a combustor that showed little to no emission degradations (W11, 1987-88 heating season).

The relationship between combustor emission performance and CO conversion percentages between new and used combustors appears to be undetermined based on the data in Table 2.6. Further refinements in the

Table 2.5

Particulate Emissions Results

Combustor	Run #	Burn Rate (dry kg/hr)	Method 5G Particulate Emissions	
			(unadj., g/hr)	(E adj., g/hr)
W07	1A	1.81	8.149	10.38
	2A	1.24	8.754	11.02
	3A	0.79	14.708	16.95
	4A	2.83	27.480	28.47
W11	1B	1.66	3.814	5.53
	2B	3.10	5.018	6.94

Weighted particulate emission rates over four test runs (Combustor W07, runs 1A-4A):

EPA: 13.99 grams per hour.
Oregon: 14.07 grams per hour.

Table 2.6

Summary of Catalyst Bench Tester Results

Combustor		Stove Code[b]	Home Code	Thickness		Cell Density (#/in²)	Estimated Use (hrs)	Light-off Temperature[c]		% Conversion @600°F (316°C)		Temperature @50% Conv. CO		Max. Propane Conversion		
															TC2	
Run	Code[a]			(in)	(mm)			°F	°C	CO	Propane	°F	°C	%	°F	°C
V1	C	—	—	2	51	16	0	395	202	100	90	342	172	93	819	437
4B	P	—	—	2	51	16	0	743[d]	395	100	75	130	54	87	764	407
3	P-1	BK	W07	2	51	16	3000	[e]	[e]	100	5	379	193	7	642	339
4	P-1	BK	W11	2	51	16	3000	[e]	[e]	93	5	377	192	5	256	124
2	C-2	BK	W07	2	51	16	5600	363	184	65	7	570	299	7	650	343
6	C-2	BK	W11	2	51	16	4000	680	360	100	10	303	150	10	722	383

a. C = Corning "Long Life"; P = Panasonic "Honeycomb". 1 = 1986-87 heating season. 2 = 1987-88 heating season.
b. BK = "Blaze King".
c. Based on difference of TC 1 > TC2 of 50°F (10°C).
d. Large combustor surface area apparently caused greater heat loss. Positioning and accuracy of thermocouples were confirmed.
e. Difference between TC1 and TC2 less than 50°F (10°C) over recorded temperature range.

bench tester design would possibly allow a more quantitative assessment of the relationship between CO/propane conversion rates and emission reduction performance as determined by other test methods.

A more complete description of the operational procedures of the woodstove catalytic combustor bench tester and test results can be found in Appendix 5.3.

3.0 Conclusions

1. The inspections conducted in Whitehorse revealed continuing degradation of key emission control components of the woodstove in home W07. The homeowner did not appear to be aware of any of the problems discovered. The stove operator claimed he had read the stove operation/maintenance manual but relied on his chimney sweep for maintenance guidance. This observation indicates the continuing problem of operators of catalytic woodstoves in determining if repairs or replacement of key emission control components are needed.

2. The weld crack on the upper plate of the secondary air manifold in the stove in home W11 is disturbing. Further degradation of this critical emission control component may lead to premature catalytic combustor failure. This problem may be related to either manufacturing quality control problems or a basic design problem which caused the weld cracks observed in the stoves in homes W07 and W11.

3. Woodstove certification tests using EPA Methods 5G/28 indicated significant catalyst degradation in the combustor from home W07 and little to no degradation in the combustor from home W11. The data may imply that one or more of the problems revealed in stove inspections, e.g., improperly set thermostat, have caused premature catalyst failure.

4. While replacement of bypass damper door gaskets appeared to significantly reduce leak rates as determined by the Leak Test Device (LTD), the "after maintenance" leak rates were still 200–400% higher than for a similar stove located in Portland, Oregon. This difference may be attributable to leaks that were not visible or accessible. This observation raises continuing questions about the need for manufacturing quality control.

5. The catalytic combustor bench tester indicated significant differences in the percentage of propane conversion at 316°C between new (unused) combustors and combustors used in homes W07 and W11. However, the measure of propane conversion could not determine significant performance differences between used combustors that demonstrated elevated emission rates and a combustor that showed little or no emission reduction performance based on EPA Methods 5G/28. The relationship between combustor emission performance and CO conversion rates between new and used combustors could not be determined. Further refinements in the design of the bench tester will be needed to more accurately quantify the relationship between carbon monoxide and propane conversion rates and the emission reduction performance of combustors as determined by other test methods, e.g., EPA Methods 5G/28.

6. The continued degradation of several critical emission control components in the woodstove in home W07 over two heating seasons and the observed weld crack in the secondary air manifold in the woodstove in home W11 after one heating season raise serious questions as to the durability of the materials used in these woodstoves.

4.0 References

1. Simons, C.A.; Christiansen, P.D.; Pritchett, L.C.; and Beyerman, G.A.. "Whitehorse Efficient Woodheat Demonstration." Prepared for the City of Whitehorse and Energy, Mines and Resources Canada. September 1987.

2. Simons, C.A. "Final Report - Particulate Emission Test, Emission Control System Inspection and Leak Check - Blaze King "King" in Home P02." Prepared for the Oregon Department of Environmental Quality and the Environmental Protection Agency. April 1988.

3. United States Environmental Protection Agency. Standard of Performance for New Stationary Sources; New Residential Wood Heaters. Federal Register, Volume 53, Number 38, Section 40 CFR, Part 60. February 26, 1988.

4. Task 2A – Development of Catalytic Combustor Bench Tester, Work Program for Third Year Activities, Northeast Cooperative Woodstove Study. July 1987.

5. Corning Glass Works, Trouble Shooting Guide for Stoves Equipped with Corning Catalytic Combustors. New York, 1986.

6. Monthly Meteorological Summaries, Environment Canada, Atmospheric Environmental Service. Whitehorse, Yukon. September 1987 to September 1988.

Appendix 5.1
Questionnaires - Woodstove Use and Wood Consumption
Homes W07 and W11

HOME CODE W 07

WHITEHORSE

Evaluation of Blaze King "King" Woodstove Use and Wood Consumption

I. Woodstove Installation Information

A. Woodstove Operator(s) _____

_____

B. Home Address _____

_____

C. Telephone Number(s) _____

D. Identification Number 6110699 (Serial Number) WH 6110699 (Manu. Date Code)

E. Catalyst Corning (Manufacturer) "Long Life" (Model)

F. Date Woodstove Installed 1/87

G. Date Catalyst Installed 8/87

H. Chimney System

☑ Prefab Metal

☐ Masonry

I. Home Type and Floor Area NEWER SINGLE FAMILY CUSTOM (BUILT 1978) TWO STOREY 195 SQ. METERS (2100 SQ. FEET)

J. Location of Woodstove BASEMENT FAMILY ROOM

K. General Description of Insulation/Weatherization in Home:

WINDOWS - WOOD FRAMED + DOUBLE. PANED.
CEILING - 8" FIBREGLASS BATTS. MAIN WALLS - 2x4
3.5" OF FIBREGLASS - BASEMENT 3.5" - FIBREGLASS BATTS
ON WALLS - LEAKS AROUND DOORS + WINDOWS -

II. Woodstove Use Information

A. Your estimate of how much wood was used (in cords) since the catalytic combustor was installed:

10.0
Cords

B. What species of wood did you use during the 1987-88 heating season?

Species	Percentage of total
"FIRE KILLED" Lodgepole Pine	100%
Total	100%

C. Where is wood stored? UNCOVERED - BACK of HOME

D. How frequently is the stove and chimney system cleaned?

TWICE SINCE NOVEMBER 1987

E. Typically, how many hours is the stove in use during the heating season?

24 "cold" days

4 hrs - Morning; 4 hours - Evening "warmer" days

F. How frequently was the stove fueled per day?

4 times "cold" days

2 times "warmer" days

G. Typically, how large is the fuel load relative to the firebox?

LOAD	Time COLD	Time WARM	% of Firebox filled "COLD" DAYS	% of Firebox filled "WARMER" DAYS
1st of Day	6:00 AM	0600	PACKED	PACKED
2nd of Day	12:00	1700	"	"
3rd of Day	1700		"	
4th of Day	2300		"	
5th of Day				

H. Where do you normally set the thermostat on the stove? Indicate number(s). Do you make any change based on the outside temperature or time of day?

ON "COLDER" DAYS - BETWEEN 2 AND 3 - then TURN thermostat to just below 1 (width of finger).
WARMER DAYS - SAME AS "COLD" DAYS

I. Do you ever leave the fueling door open while the stove is operating? Under conditions?

only when first starting the stove

J. Other than cord wood or kindling, are there any other materials (e.g., trash, newspaper, garbage) burned in the stove? If yes, how frequently? How much?

Materials	How freqently	How much
NEWSPAPER		Just to start

K. Has the catalyst been replaced since you purchased the stove? If yes, why? (Also provide information on previous catalyst's manufactuer, model, disosition, etc.)

Catalyst replaced August 1987 AS part of Whitehorse Efficient Woodheat Demonstration Study. Original Catalyst (Panasonic - installed 1/87) replaced with Corning "Long Life" on 8/87.

L. Have you had any problems with woodstove operations, for example, catalyst lightoff or mechanical problems?

No

M. Are you familiar with the manufacturer's instruction manual regarding operating and maintenance procedures? What maintenance procedures do you perform?

REVIEWED INSTRUCTIONS WHEN WE FIRST OPERATED THE STOVE.

WE RELY UPON OUR CHIMNEY SWEEP FOR GUIDANCE ON STOVE MAINTENANCE.

N. During the 1987-88 heating season, were there any significant periods of time the stove was not in use, due to vacation, etc.? If yes, when?

TWO WEEKS TOTAL - MOSTLY LONG WEEKENDS.

O. Any other comments:

WE like the stove. lots of heat output

HOME CODE W 11

WHITEHORSE

Evaluation of Blaze King "King" Woodstove Use and Wood Consumption

I. Woodstove Installation Information

A. Woodstove Operator(s) _____

_____

B. Home Address _____

_____

C. Telephone Number(s) _____

D. Identification Number 7100301 (Serial Number) WH 710030! (Manu. Date Code)

E. Catalyst CORNING (Manufacturer) "LONG LIFE" (Model)

F. Date Woodstove Installed 9/87

G. Date Catalyst Installed 9/87

H. Chimney System

☑ Prefab Metal

☐ Masonry

I. Home Type and Floor Area NEWER SINGLE FAMILY CUSTOM TWO ~~STORY~~ - 204 SQ. METERS (2200 SQ. FEET)

J. Location of Woodstove UNFINISHED BASEMENT

K. General Description of Insulation/Weatherization in Home:

CEILING - 6" FIBERGLASS BATT WITH 12" LOOSE FILL INSULATION. WALL 2X4" CONSTRUCTION WITH 3.5" FIBERGLASS BATTS WINDOWS - DOUBLE GLAZED. LEAKAGE AROUND ~~DOORS~~, WINDOWS, BATHROOM VENT, WALL PLUGS, LIGHT SWITCH BOXES

II. Woodstove Use Information

A. Your estimate of how much wood was used (in cords) since the catalytic combustor was installed:

4.0 (Previous stove 6.0 cords - Ave.)
Cords

B. What species of wood did you use during the 1987-88 heating season?

Species	Percentage of total
"Seasoned" Lodgepole	100%
PINE	
Total	100%

C. Where is wood stored? Under Deck - Covered

D. How frequently is the stove and chimney system cleaned?

ONCE every SIX WEEKS (Previous stove every 2 WEEKS)

E. Typically, how many hours is the stove in use during the heating season?

24 hours "cold" days

start in evenings - let "run" overnight "warmer" days

F. How frequently was the stove fueled per day?

3 "cold" days

2 "warmer" days

G. Typically, how large is the fuel load relative to the firebox?

LOAD	Time COLD	Time WARM	% of Firebox filled "COLDER" Days	% of Firebox filled "WARMER" Days
1st of Day	0630	1730	PACKED	1/2 full
2nd of Day	1730	2200	"	PACKED
3rd of Day	2200		"	
4th of Day				
5th of Day				

H. Where do you normally set the thermostat on the stove? Indicate number(s). Do you make any change based on the outside temperature or time of day?

"Cold" days - Just about but not quite full open
"Warmer" days -- Just past "1" on thermostat - just enough to keep Combustor operating

I. Do you ever leave the fueling door open while the stove is operating? Under conditions?

YES - but only when starting fire.

J. Other than cord wood or kindling, are there any other materials (e.g., trash, newspaper, garbage) burned in the stove? If yes, how frequently? How much?

Materials	How freqently	How much
NONE - only wood		

K. Has the catalyst been replaced since you purchased the stove? If yes, why? (Also provide information on previous catalyst's manufactuer, model, disosition, etc.)

NO

L. Have you had any problems with woodstove operations, for example, catalyst lightoff or mechanical problems?

NONE - SINCE Replacement STOVE WAS INSTALLED IN 9/87.

M. **Are you familiar with the manufacturer's instruction manual regarding operating and maintenance procedures? What maintenance procedures do you perform?**

NOT FAMILIAR with MAINTENANCE - INSTRUCTIONS. NO MAINTANANCE except SWEEPING of CHIMNEY.

N. **During the 1987-88 heating season, were there any significant periods of time the stove was not in use, due to vacation, etc.? If yes, when?**

TWO WEEKS AT CHRISTMAS TIME

O. **Any other comments:**

OCASSIONLY NOISE from FANS. Heat from SIDES NOT AS MUCH AS FROM PREVIOUS STOVE (RSF-65). On "coldest" days would prefer MORE heat output. OVERALL like the STOVE VERY much.

Appendix 5.2
Test Data Report
EPA Method 5G/28 Emission Tests

TEST DATA REPORT

Prepared for: Energy, Mines, and Resources Canada
2078 2nd Avenue
Whitehorse, Yukon
CANADA Y1A 1B1

Prepared by: OMNI Environmental Services, Inc.
10950 SW Fifth Street, Suite 160
Beaverton, OR 97005

November 9, 1988

PS342-01

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ENERGY, MINES, AND RESOURCES, INC.

PS342-01

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INTRODUCTION

INTRODUCTION

Energy, Mines and Resources, Inc. retained OMNI Environmental Services, Inc., to perform emissions and efficiency testing on two field-test combustor units. The combustors were installed in the Model Blaze King King KEJ-1101 woodstove. The testing was conducted in accordance with the Environmental Protection Agency (EPA) 40 CFR Part 60, Subpart AAA — Standard of Performance for Residential Wood Heaters, as promulgated on Friday, February 26, 1988 and the Oregon Department of Environmental Quality (DEQ) "Standard Method for Measuring the Emissions and Efficiency of Woodstoves," dated June 8, 1984. Emissions were measured using the EPA Methods 28, and 5G-1. The testing was performed October 27 through November 3, 1988 at the OMNI Solid Fuels Testing Laboratory in Beaverton, Oregon.

Six test runs were completed, four with combustor W07-2 and two with combustor W11-2. Efficiencies and particulate emissions were measured. Summary Tables, reduced data results, and process raw data sheets are included for each run. The EPA particulate emissions weighted average for the four runs conducted with combustor W07-2 was 13.99 grams/hour. The Oregon DEQ particulate emissions weighted average was 14.07 grams/hour.

The report is organized in seven sections. Following a general Introduction in Section I, Results are summarized and then discussed in Sections II and III. In Section IV are provided brief descriptions of the methods, alternatives, and equipment used by the laboratory. Calibrations performed at 6-month intervals are provided in Section V. Sample calculation worksheets for all computer generated results are in Section VI. And finally, all raw data and computer generated results for each run are in Section VII. The runs are placed in ascending burn rate order. Raw data includes fuel parameters, Method 5G-1 traverse and sampling, pretest and test start operation, and all 10-minute data. Computer generated data includes calculation of burn rate and Method 5G emissions rate.

SUMMARY OF RESULTS

SUMMARY TABLE 1

PARTICULATE EMISSIONS RESULTS

RUN #	BURN RATE KG/HR DRY	METHOD 5G PARTICULATE EMISSIONS (unadjusted) GRAMS/HOUR	METHOD 5G PARTICULATE EMISSIONS (E ADJ) GRAMS/HOUR
Combustor W07-2			
1A	1.81	8.149	10.38
2A	1.24	8.754	11.02
3A	0.79	14.708	16.95
4A	2.83	27.480	28.47
Combustor W11-2			
1B	1.66	3.814	5.53
2B	3.10	5.018	6.94

EPA weighted particulate emission rate over four test runs (Combustor W07-2, runs 1A-4A): 13.99 grams per hour.

Oregon Weighted particulate emission over four test runs (same as above): 14.07 grams per hour.

SUMMARY TABLE 2

OREGON DEQ EFFICIENCY RESULTS

Run #	HEAT OUTPUT Btu/HOUR**	EFFICIENCIES (%) OVERALL*	COMBUSTION	HEAT TRANSFER	CARBON MONOXIDE EMISSIONS (GRAMS/HOUR)
Combustor W07-2					
1A	24,686	70.5	85.0	83.0	113.225
2A	16,392	68.4	83.5	82.0	89.982
3A	10,038	65.5	75.8	86.5	112.320
4A	34,451	62.9	79.8	78.8	405.890
Combustor W11-2					
1B	21,344	66.4	81.3	81.7	109.894
2B	40,273	67.2	81.3	82.7	349.204

Oregon Weighted overall efficiency: 67.2%.

* Corrected for stove thermal mass.

** Assumed Higher Heating Value of 8765 Btu/lb. used in calculation.

SUMMARY TABLE 3

SUMMARY OF HEATER OPERATION

TEMPERATURE DATA*

	Surface						Combustor		
Run #	Top	Bottom	Back	Left	Right	Delta T**	Upstream	In	Downstrm
Combustor W07-2									
1A	416	345	247	400	411	+17	939	1226	829
2A	344	266	192	328	317	+19	620	1088	633
3A	220	190	141	276	243	+83	485	660	368
4A	454	443	297	522	583	-59	1090	1216	814
Combustor W11-2									
1B	402	346	244	379	393	-20	876	1201	765
2B	548	469	348	582	616	-75	668	1398	1025

* All temperatures in Degrees Fahrenheit
**Difference between average surface temperature at beginning of test and average temperature at end of test.

DISCUSSION OF RESULTS

There was a total of six runs conducted. Test runs were conducted with combustor W07-2 in the following categories: one in the <0.80 kg/hr dry; one in the 0.80-1.25 kg/hr dry category; one in the 1.26-1.90 kg/hr dry category; and one at maximum. Test runs were conducted with combustor W11-2 in the following categories: one in the 1.26-1.90 kg/hr dry category; and one at maximum.

A system leak check was performed before run 1A with combustor W07-2; with combustor W11-2 after test 1B was completed; with combustor W07-2, prior to run 2A and after 4A was completed. Leak check data is provided in Section VII of the report.

TEST CONFIGURATION		
RUN # COMB. #	FIVE-MINUTE STARTUP	PRIMARY AIR TEST SETTING
1A W07-2	Fuel loaded: 1:20 mins. Door and bypass closed at: 1:20 mins. Primary air: Set on full high for 5:00 mins., then slowly set to test setting.	Just above 2 on the dial.
2A W07-2	Fuel loaded: 1:30 mins. Door and bypass closed at: 1:30 mins. Primary air: Set on full high for 4:30 mins., then slowly set to test setting by 5:00 mins.	Just below 1.5 on the dial.
3A W07-2	Fuel loaded: 1:05 mins. Door and bypass closed at: 1:05 Primary air: Set on full high for 4:00 mins., then slowly set to test setting by 5:00 mins.	Below 1 on the dial.
4A W07-2	Fuel loaded: 0:54 mins. Door and bypass closed at: 0:54 mins. Primary air: Set on full high for startup.	Full high.
1B W11-2	Fuel loaded: 1:15 mins. Door and bypass closed at: 1:15 mins. Primary air: Set on full high for 4:30 mins., then slowly set to test setting by 5:00 mins.	Just above 2 on the dial.
2B W11-2	Fuel loaded: 1:30 mins. Door and bypass closed at: 1:30 mins. Primary air: Set on full high for startup.	Full high.

Fan set at high for all tests.

METHODS USED AND ALLOWABLE ALTERNATIVES

TEST SAMPLING AND ANALYTICAL PROCEDURES

Sampling and analytical procedures were conducted in accordance with EPA 40 CFR Part 60, Subpart AAA - Standard of Performance for Residential Wood Heaters, as promulgated on Friday, February 26, 1988 (Appendix A Methods 28 and 5G-1). Details of each specific method are addressed below.

Method 28 - Certification and Auditing of Wood Heaters

The stove was installed on a platform scale in test booth #1 in accordance with any written manufacturer installation instructions. Clean single wall duravent flue pipe to a height of 8.5 feet (+/- .5 feet) above the scale and surface thermocouples (Type K) were installed on the stove. Sampling probes and sensor instrumentation were installed through flue ports located 8.5 feet above the floor of the test chamber. Insulated pipe was installed above the sample ports to a height of 15 feet (+/- 1 foot). The draft pressure was recorded at 8 inches above the appliance flue collar. Ambient temperature was recorded by a thermocouple located in the test booth, 3 feet in front of the stove and on a horizontal plane with the stove air inlets. A psychrometer, mercury barometer, and vane anemometer for facility measurements are located in other areas of the laboratory.

The fuel used for the testing was Douglas-fir species lumber, 2x4 and 4x4 nominal dimensions, standard grade, air-dried, and untreated.

Prior to the start of each test, the appliance was operated for a minimum of 60 minutes to establish a coal bed under the same conditions as the test. The stove was set during the pretest at the setting(s) necessary to achieve each of the specified test burn rates. Each test was begun when the pretest fuel weight was 20-25% of test fuel weight. Operation of the appliance at the start of each test consisted of loading the test fuel load and manipulating the fuel loading door for the first five minute phase to ensure good ignition of the test charge. Full start-up operations are summarized in tables located in this section of the report and are recorded for each run on the Run Notes raw data sheet. Particulate sampling and stove monitoring continued until the test load was completely burned.

Test facility, fuel weight loss, and surface temperature data is recorded on the laboratory automated data logger system which is monitored by a technician during the entire test. For booth 2 the data is recorded manually.

TEST SAMPLING AND ANALYTICAL PROCEDURES (CONT.)

Method 5G-1 - Determination of Particulate Emissions from Wood Heaters from a Dilution Tunnel Sampling Location

Sampling: Particulate sampling was synchronized with test fuel loading and continued until the test load was completely burned. Sampling was collected from one port in the tunnel located 29 feet 8 inches for booth 1, or 20 feet 7 inches for booth 2, from the bottom of the hood. The sample flow rate was approximately 0.50 cfm. Changes to the sample flow rate were adjusted every ten minutes if necessary to correspond to changes in the tunnel flow. Velocity measurements were taken in the tunnel 25 feet 8 inches for booth 1, or 16 feet 4 inches for booth 2, from the bottom of the hood. A pre-test velocity traverse was preformed as specified by EPA, Method 2 (CFR Part 60 Appendix A). The standard pitot tube was mounted in the tunnel at the average velocity point. Dilution tunnel flow rates were measured every ten minutes.

Ten-minute data points are recorded manually.

Analysis: Sample recovery and analysis occurred in the same room. The filters were removed from the holders and placed in plastic petri dishes for desiccation to a constant weight. Each filter was weighed separately and without the petri dish. The filters were handled with tweezers. Care was taken to ensure recovery of all filter pieces during handling and transfer operations.

The probe, filter holders, filter support, and gaskets were brushed and rinsed with acetone. The rinse was collected in a glass tared beaker. The contents of the glass beaker was evaporated at ambient conditions, and desiccated and weighed to a constant weight.

DESCRIPTION OF ALLOWABLE ALTERNATIVES

METHOD 28

Fuel Temperature Specification: OMNI currently uses a correction factor for room temperature in the reporting of fuel moisture. The correction factor is published by Delmhorst Moisture Meter Company for the purpose of correcting the meter to room temperature. A graph of meter readings for correction to actual dry basis moisture is used by the technicians at OMNI and a copy is provided in this section of the report. The graph also includes a correction for insulated pins and a 2-pin probe instead of a 4-pin probe.

DESCRIPTION OF ALLOWABLE ALTERNATIVES (CONT.)

METHOD 5G-1

The following variable items are used in the OMNI Dilution Tunnel System:

Probe: Stainless steel material.
Pitot tube: Standard type with coefficient value of 0.99.
Differential Pressure Gauge: Inclined liquid manometer for booth 1 or a magnehelic gauge for booth 2.
Filter Holder System: Teflon holders; stainless steel frits; teflon and silicone rubber gaskets.

A complete list of equipment is provided in this section of the report.

The assumed value of 4 percent tunnel moisture is used in the calculation of the average gas flow rate.

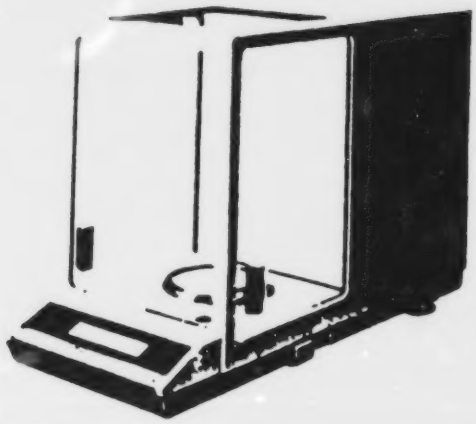
The pitot tube is placed in the tunnel at the average velocity point obtained from the initial velocity traverse.

The Mettler electronic balance used in sample analysis is calibrated by the internal 100 gram weight (Class S) and the internal zero calibration. The specifications of the balance are included in this section.

Mettler

Electronic analytical balances

AE50 55 g / 0.1 mg
AE100 109 g / 0.1 mg
AE160 162 g / 0.1 mg
AE200 205 g / 0.1 mg



Operating Instructions

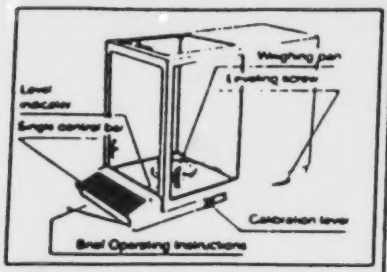
Mettler

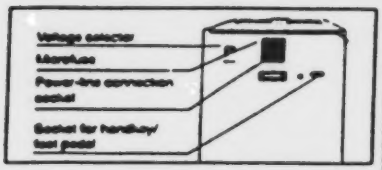
Leveling the balance	Calibrating the balance	Integration time	Stability detector	Taring; weighing
	AE50: 50.0000 g AE100 / AE160 / AE200: 100.0000 g	Steps 1/2/3	Steps 1/2/OFF	Ranges: AE50 0...55 g AE100 0...109 g AE160 0...162 g AE200 0...205 g

009 A

Operating Instructions AE50/100 AE160/200 METTLER

OPERATING ELEMENTS AND CONNECTIONS





PRELIMINARY STEPS

Checking the operating voltage

The operating voltage setting must agree with your local power-line voltage; please check this setting and, if needed, change it.

Admissible power-line voltage in the switch positions
115 V: 92 V...132 V
220 V: 184 V...265 V

Location

- A stable location, as free from vibration as possible.
- Make sure there are no large temperature fluctuations.
- Avoid direct sunlight and drafts.
- Connect the power cable at the work station.

Installing the weighing pan/leveling the balance

- Place weighing pan on balance; the conical peg centers the pan in the opening in the base of the weighing chamber.
- The two leveling screws should be adjusted so that the bubble is in the middle of the circle.

Whenever the location of the balance is changed, the balance should be releveled.

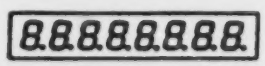
OPERATION

Brief Operating Instructions

Brief Operating Instructions can be found on a card that swings out from underneath the balance housing.

Switching the display on/off

- Briefly press the single control bar; all display segments light up for several seconds:



- Afterwards, the display automatically sets itself to 0.0000.
- Lightly lift the control bar; the display is switched off.

Calibration

Make absolutely sure:
The balance must be left connected to the power supply for at least 60 minutes before "calibrating".

Taring

- Open the sliding glass door
- Place a tare container on the weighing pan
- Close the sliding glass door
- Press the control bar briefly, the display changes to 0.0000 -

The weight of the container is now tared out. To weigh-in, the balance weighing range - minus the weight of the tare container - is now available.

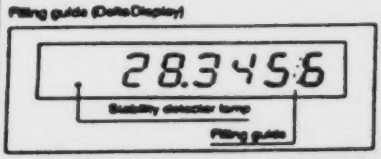
Note: It is possible to carry out external taring by using the handkey or foot pedal from the "ACCESSORIES optional" (connection sockets on rear of balance)

Weighing-in

- Open the sliding glass door
- Fill in substance up to the desired target weight (to read the weight accurately, the door must be closed)

If different components are to be weighed, one after the other, into the same container, it is possible to tare after each weighing and start the next weighing from zero. This can be done until the tare container and all the components together reach the end of the weighing range.

Filling guide (DeltaDisplay)

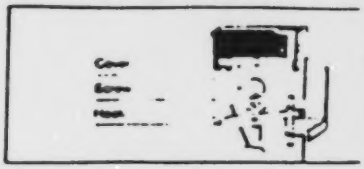


The filling guide (DeltaDisplay) switches on automatically when weighing in substances quickly; the last two digits are blanked out and the display change sequence speeds up. This allows the increase in weight to be followed better. When weighing in slowly towards the target weight, the two digits switch back on.
The display change sequence remains rapid. Only when weight changes are very small does the balance switch back to the normal display change with the full number of decimal places.

Stability detector:
When stability is achieved (determined by the step selected for the stability detector), the green dot in the display goes out.
The result is then stable.

Note: When the green dot lights up in the display, the data interface is blocked; when the green dot goes out (stability), the data interface is unblocked.

FURTHER CAPABILITIES



GD hanger (for weighing below the balance)

- Open all sliding glass doors
- Remove the weighing pan. Disconnect power cable
- Place the balance on its back
- Loosen the screw on the bottom of the balance
- Swing the cover to one side
- Retighten the screw

A hook is visible in the opening, the object or substance can be weighed by attaching a hanger from the hook.

- Place the balance back on its feet, place the weighing pan back on and level the balance. Plug in power cable.
- With the hanger attached to the hook, press tare

Note: The weighing pan does not have to be placed back on if the hanger is at least as heavy as the pan. The hanger is not available from METTLER.

CARE AND MAINTENANCE

Cleaning

A cloth with some soapy water is sufficient to clean the weighing pan and housing. Do not use any strong solvents. To remove residues from the weighing chamber, use the small artist's brush that is included in the balance standard equipment (do not blow or brush the chamber).

Replacing the microfuse

- Disconnect the power cable
- Turn out the fuse holder (in the power-line connection socket) with a screwdriver.
- Replace the fuse (spare fuse 160 mA slow blow in the fuse holder).
- Place the fuse holder back on.
- Plug the power-line cable back in.

ACCESSORIES

Optional equipment		Order No
– Centering disk (for draft shield cylinder)		36609
– Draft shield cylinder, can be stacked, 1 unit		36584
– Tweezers, 210 mm long (with plastic tips)		70209
– Density (specific gravity) determination kit		40290
– Foot pedal		46276
– Handkey		42500
– Microfuses, 160 mA slow-blowing (set of 3)		66144
– Data interfaces:		
011 Option – CL/RS232C unidirectional		36750
012 Option – CL/RS232C bidirectional		36751
013 Option – IEEE488		36752
040 Data Output (unidirectional mode)		36795
Standard equipment		
– Power-line cable	neutral	67576
	Switzerland	67620
	Euro-Norm	67625
	USA	66666
– Weighing pan, 80 mm dia.		36580
– Hair-bristle brush		70114

SPECIFICATIONS	AE50	AE100	AE160	AE200
Readability	0.1 mg	0.1 mg	0.1 mg	0.1 mg
Weighing range	0...50 g	0...100 g	0...162 g	0...205 g
Tare range (subtractive)	0...50 g	0...100 g	0...162 g	0...205 g
Reproducibility (standard deviation)	0.1 mg	0.1 mg	0.1 mg	0.1 mg
Linearity	± 0.2 mg	± 0.2 mg	± 0.2 mg	± 0.3 mg
Linearity relative to 10 g	± 0.1 mg	± 0.1 mg	± 0.1 mg	± 0.1 mg
Stabilization time (typically)	6 sec			
Integration time (adjustable)	1.5/3/6 sec			
Display sequence – Mettler DeltaDisplay off	0.4 sec			
– Mettler DeltaDisplay on	0.2/0.4 sec			
Stability detector	-			
– Sensitivity selectable in three steps	1/2/off			
Sensitivity drift (10...30°C)	± 2 x 10 $^{-6}$/°C			

009B

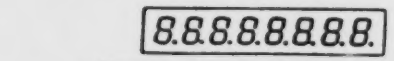
OPERATION

Brief Operating Instructions

Brief Operating Instructions can be found on a card that swings out from underneath the balance housing.

Switching the display on/off

- Briefly press the single control bar; all display segments light up for several seconds.



- Afterwards, the display automatically sets itself to 0.0000.
- Lightly lift the control bar, the display is switched off.

Calibration

Make absolutely sure
The balance must be left connected to the power supply for at least 60 minutes before "calibrating".

- Press and hold the single control bar until -CAL- appears in the display; then release control bar. The display changes to CAL—, then to CAL100 (blinks). AE 50: CAL50 blinks.
- Move calibration lever all the way to the rear; the display changes to CAL—, followed by 100.0000 (AE 50 50.0000), then to CAL0 (blinks).
- Move calibration lever all the way back towards the front of the balance; the display changes to —, followed by 0.0000.

Measuring cycle / measuring accuracy

By selecting a particular integration cycle, as well as a particular stability detection step, the balance can be configured according to your weighing location and needs.

Integration times:
Step 1: Used for very stable, vibration-free weighing tasks (short measuring cycle).
Step 2: Normal setting.
Step 3: Used for unfavorable ambient conditions (long measuring cycle).

- Press the control bar and hold it until -In1- appears in the display, then release the control bar.
- Immediately press the control bar briefly; the display will change to the next step.
- Stop at the step you wish to use and wait for the display to return to the weighing mode (0.0000).

Stability detection:
Step 1: Great sensitivity (long pause before data are released).
Step 2: Less sensitivity (short pause before data are released).
Normal setting.
Step OFF: The stability detector is switched off. Make sure that when this is the case, the filling guide (Delta Display) is also switched off (described in Paragraph entitled, "Weighing-In").

- Press the control bar and hold until -ABd- appears in the display, then release control bar.
- Immediately press control bar again briefly; the display changes to the next step.
- Stop at the step you wish to use and wait for the display returns to the weighing mode (0.0000).

Note: After selecting the integration time, you can go directly to the selection of the stability detector setting by holding the control bar down.

012 Option – [illegible]	[illegible]
013 Option – [illegible]	[illegible]
040 Data Output [illegible]	[illegible]

Standard equipment

– Power-line cable	Neutral	87570
	Switzerland	87602
	Euro Norm	87603
	USA	88662
– Weighing pan 80 mm dia		34590
– Hair bristle brush		70114

SPECIFICATIONS

	AE 50	AE 100	AE 160	AE 200
Readability	0.1 mg	0.1 mg	0.1 mg	0.1 mg
Weighing range	0...55 g	0...109 g	0...162 g	0...205 g
Tare range (subtractive)	0...55 g	0...109 g	0...162 g	0...205 g
Reproducibility (standard deviation)	0.1 mg	0.1 mg	0.1 mg	0.1 mg
Linearity	± 0.2 mg	± 0.2 mg	± 0.2 mg	± 0.3 mg
Linearity relative to 10 g	± 0.1 mg	± 0.1 mg	± 0.1 mg	± 0.1 mg

Stabilization time (typically)	5 sec
Integration time (adjustable)	1.5/3/6 sec
Display sequence – Mettler Delta Display off	0.4 sec
– Mettler Delta Display on	0.2/0.4 sec
Stability detector	
– Sensitivity selectable in three steps	1/2/off
Sensitivity drift (10...30 °C)	± 2 x 10⁻⁶/°C
Calibration weight (built-in), adjusted to an apparent mass of 8.0 g/cm³ in an air density of 1200 mg/l	100 g, adjusted to ± 0.1 mg (50 g, adjusted to ± 0.1 mg for AE 50)
Dimensions: Weighing pan	80 mm dia.
Open space above weighing pan	215 mm
Balance housing (W x D x H)	205 x 410 x 280 mm
Net weight	10.3 kg
Power supply: Voltage, adjustable	115 V, 220 V
Admissible voltage range	92...132 V, 184...265 V
Frequency	50...60 Hz
Power consumption	10 VA
Admissible ambient conditions during operation:	
Temperature	10...40 °C
Relative humidity (non-condensing)	25...85 %

WHAT'S WRONG IF...

...IF	...THEN
...the entire display does not light up?	– no power reaching the instrument – the fuse is defective.
...the OFF display appears?	– a temporary power failure has taken place. (Press the control bar.)
...only the upper horizontal segments light up in the display?	– the weighing range has been exceeded. – the calibration weight has been activated. – there was weight on the pan when the instrument was switched on.
...only the lower horizontal segments light up in the display?	– the weighing pan is not installed. – there was weight on the pan when the instrument was switched on.
...the weighing result is unstable?	– there are too many drafts. Close sliding glass doors. – the weighing table is unstable. – the integration time setting is too low. – the object being weighed is not at room temperature.
...the weighing result is obviously incorrect?	– the balance must be calibrated or has been calibrated using the wrong external weight.
...only a portion of the display lights up?	– a temporary malfunction has occurred (pull out power cable and plug it back in).
...the middle horizontal segments in the display are blinking (for more than 30 sec)?	– the weighing table or the load is too unsteady (close sliding glass doors, set a longer integration time and/or change the stability detection setting).
...CAL Err appears in the display?	– the weighing pan was not unloaded before calibrating the balance, or the wrong external calibration weight was used (return to the weighing mode by pressing and holding the control bar).
...no CAL appears in the display?	– a temporary malfunction has occurred (recalibrate balance).
...a zero display does not appear after pressing tare?	– the weighing table or the load is too unsteady (close sliding glass doors, set a longer integration time and/or change the stability detection setting).

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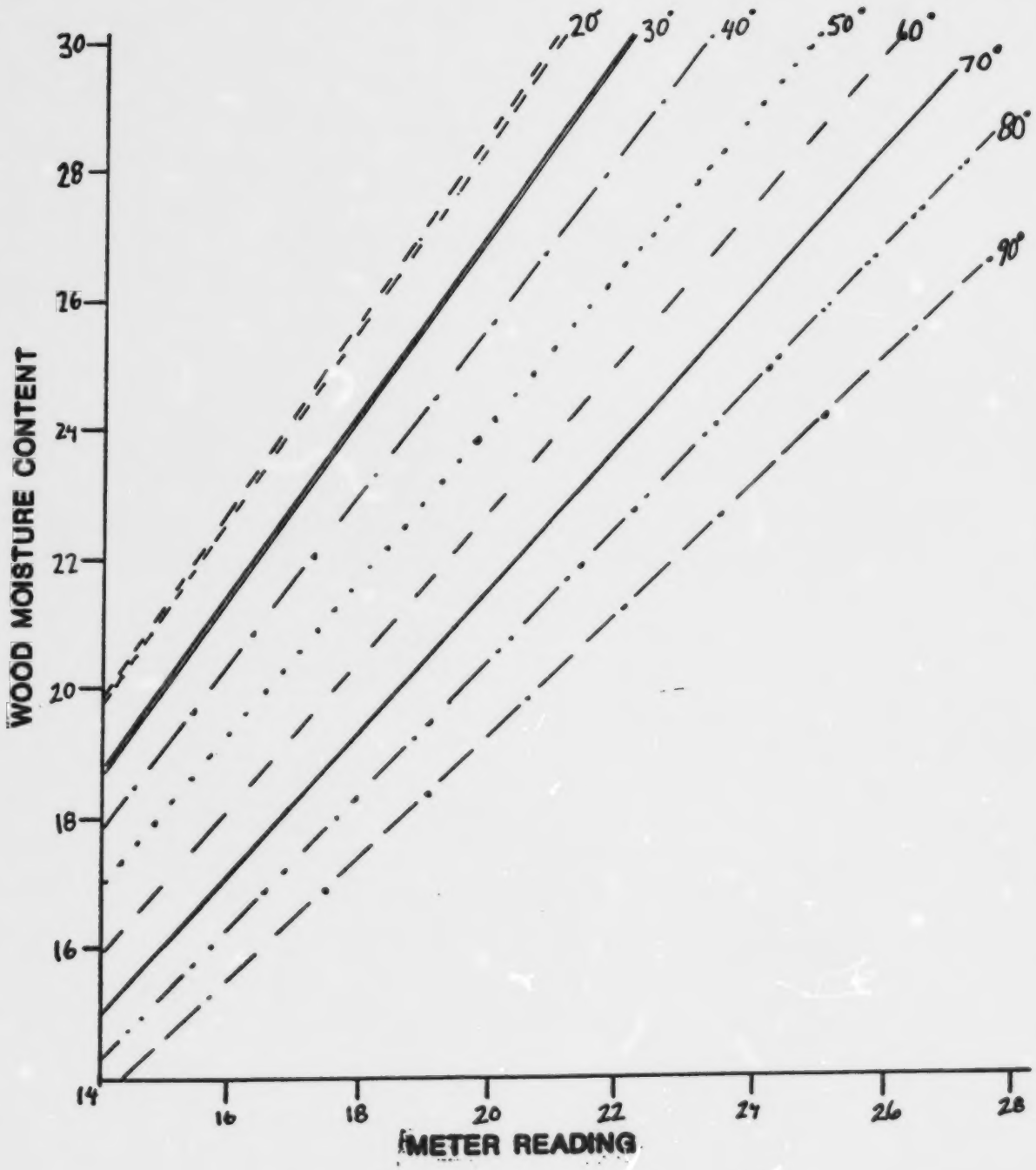
Subject to technical changes and to the availability of the accessories supplied with the instruments.

009 C



Room Temperature Moisture Meter Correction for Douglas Fir Using Insulated Pins

009 D

Source: Delmhorst Moisture Meter Model 26E Operating Instructions and Delmhorst "Instructions To Best Utilize Moisture Meters on Wood."

26-E ELECTRODE

OPERATING INSTRUCTIONS

The 26-E and 18-E Electrodes, fitted with insulated pins and used with any Delmhorst Moisture Detectors for Wood, are valuable in detecting moisture gradient in lumber or in testing dry stock that is wet on the surface.

These Electrodes, as long as they have good insulation on their shanks, measure moisture content at the tip of the pins only, that is in a layer about 3/16" thick.

Shell and core moisture content is easily measured by driving the pins to the proper depths.

When using the Electrode, place the pins on the wood so that the current will flow parallel to the grain and drive the pins into the wood by means of the sliding hammer. Note the pins' penetration, and read the meter.

The Moisture Meter is calibrated for use with a 4-pin Electrode. When using a 2-pin Electrode, a small correction should be applied, as noted below, where line "A" shows meter readings, and line "B" the correct readings for the 2-pin Electrode.

A= 7	8	10	12	14	16	18	20	22
B=7.3	8.4	10.6	12.8	14.9	17.0	19.2	21.4	23.7

When the insulation on the contact pins wears off the above correction should be disregarded, and the electrode should not be used on lumber which may have a wet surface.

DELMHORST INSTRUMENT CO. BOONTON, NJ 07005
6/84

WOOD TEMP	METER READINGS												
°C	°F	6	7	10	15	20	25	30	35	40	50	60
-20	0	-3	-4	-5	-7	+11	+13	+16	+18			
-15	20	-2	-3	-4	-5	+8	+9	+10	+12	+16		
-10	40	-1	-1	-2	-3	-4	+5	+6	+7	+8		
-5	60	0	0	-1	-1	-1	-2	-2	+3	+3	+4	
0	80	0	0	-1	-1	-1	-2	-2	-2	-2	-3	-5
5	100	-1	-1	-2	-3	-3	-4	-5	-6	-6	-8	-10
10	120	-1	-2	-3	-4	-5	-6	-8	-9	-10	-12	-16
15	140	-2	-2	-3	-5	-6	-8	-10	-12	-14	-16	-20
20	160	-2	-3	-4	-6	-8	-10	-12	-14	-16	-20	-24
25	180	-3	-3	-5	-7	-9	-12	-14	-16	-18	-23	-27
30	200	-3	-3	-5	-8	10	-13	-16	-18	-21	-26	-32
35	220	-4	-4	-6	-9	-11	-14	-17	-20	-23	-29	-34

Values of moisture content in the shaded area are only indicative, since they are above the fiber saturation point.

Example: If the meter reads 7% and the temperature is 160°F (dry bulb), actual moisture content is 4%.

When making a test first apply temperature correction then add or subtract species correction as shown on the table below.

NOTE: The temperature correction values shown in the chart have been rounded for easy reference. The use of a Temperature Correction Slide Rule is recommended as it makes it easier to interpolate meter readings and correction values in small gradual increments. A Slide Rule is supplied with each moisture meter. Additional ones are available upon request.

CORRECTION TABLE FOR VARIOUS SPECIES OF WOOD

SPECIES	METER READINGS										
	7	8	9	10	12	14	16	18	20	22	24
ASH, WHITE	-0.6	-0.6	-0.8	-0.9	-1.2	-1.1	-1.5	-1.8	-2.1	-2.5	-2.9
BASSWOOD	0.2	-0.3	-0.9	-1.3	-1.5	-1.3	-1.2	-1.2	-1.3	-1.4	-1.7
BIRCH	0.9	1.0	0.8	0.7	0.9	1.0	1.0	1.3	1.4	1.4	1.6
CEDAR, INCENSE	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	1.0	1.2	1.3
CHERRY	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.1
CYPRESS	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	-0.4	-0.6	-0.6
ELM, AMERICAN	-0.1	-0.4	-0.9	-1.4	-2.1	-2.5	-2.8	-3.1	-3.8	-4.2	-4.7
FIR, DOUGLAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIR, RED	0.3	0.3	0.2	0.1	0.5	0.8	1.1	1.2	1.2	1.0	1.2
FIR, WHITE	0.9	0.9	0.6	0.6	0.5	0.7	1.0	1.0	1.0	1.0	1.2
GUM, BLACK	0.5	1.1	1.1	1.1	1.0	0.8	0.3	-0.5	-1.0	-1.4	-1.8
GUM, RED	0.3	0.3	0.3	0.3	0.4	0.6	0.6	0.7	0.5	0.4	0.3
HEMLOCK	0.1	0.2	0.2	0.4	0.7	0.8	0.8	0.7	0.4	-0.2	-0.6
HICKORY	1.1	0.7	0.2	-0.3	-0.8	-1.4	-2.0	-2.4	-2.8	-3.2	-3.6
LARCH	0.5	0.6	0.9	0.8	1.0	1.2	1.2	1.3	1.2	1.3	1.5
MAGNOLIA	0.5	1.1	1.3	1.6	1.6	1.9	1.6	1.3	0.7	0.0	0.5
MAHOGANY, AFRICAN	0.7	1.4	1.6	2.0	2.6	3.2	3.6	3.8	3.8	3.8	3.8
MAHOGANY, HOND.	0.3	0.3	0.3	0.4	0.6	0.5	0.2	0.0	0.5	-1.0	-1.5
MAHOGANY, PHIL.	-1.2	-1.2	-1.5	-1.9	-2.4	-2.8	-3.3	-3.7	-4.5	-5.2	-5.8
MAPLE, SUGAR	0.9	0.9	0.6	0.1	-0.2	-0.1	-0.2	0.0	0.2	0.5	1.0
OAK, RED	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0
OAK, WHITE	-0.1	-0.2	-0.4	-0.4	-0.5	-0.5	-0.8	-1.1	-1.5	-1.8	-2.0
PINE, LONGLEAF	0.2	0.6	0.7	0.8	1.2	1.5	1.6	1.5	1.3	1.1	1.0
PINE, PONDEROSA	0.4	0.6	0.9	1.0	1.4	1.6	1.6	1.4	1.2	1.2	1.0
PINE, SHORTLEAF	0.5	0.8	0.8	0.8	1.2	1.4	1.6	1.6	1.5	1.4	1.3
PINE, SUGAR	0.0	0.0	0.0	0.0	0.2	0.0	0.8	0.9	1.0	0.9	0.8
PINE, WHITE	0.0	0.2	0.2	0.3	0.7	1.1	1.2	1.5	1.1	1.0	1.5
POPLAR, YELLOW	0.1	0.6	0.7	0.7	1.2	1.6	1.6	1.6	1.7	2.0	1.7
REDWOOD	0.0	0.0	0.0	0.0	-0.2	-0.5	-0.8	-1.0	-1.0	-0.2	0.0
SPRUCE, SITKA	0.0	0.2	0.3	0.3	0.5	0.6	0.6	0.9	1.0	1.4	1.9
WALNUT, BLACK	0.5	0.6	0.4	0.4	0.4	0.5	0.5	0.2	0.0	-0.2	-0.4

Example: When testing birch and the Moisture Detector reads "10", look opposite birch and under the Moisture Detector Reading of 10; the correction is + 0.7, which, added to the initial reading, gives a "temperature corrected reading" of 10.7.

1600 H

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6522-1184

INSTRUCTIONS
TO BEST UTILIZE MOISTURE METERS ON WOOD

1. **MOISTURE CONTENT RANGE:** Moisture Detectors operate best for measuring moisture content in wood over a range of 7% to 25-30% (fiber saturation point). Because of the extremely high electrical resistance found in wood with very low moisture content, it is not always easy to make tests below 7% especially if tests are made under very dry ambient conditions (RH below 20%). Readings at low moisture content are more accurate than at high moisture content. The expected accuracy is as follows: within 5% from 6-12%; within 1% from 12-20% and within 2% from 20% to fiber saturation point. Above the fiber saturation point, the readings are of limited value: they are usually lower than the actual moisture content. The variations are erratic and change from species to species.

At elevated wood temperatures, indicated values above 30% are valid if, after applying the temperature correction (see section 7), the resulting true moisture content is below fiber saturation.

2. **THICKNESS OF MATERIAL:** Electrodes having a penetration of 5/16" should not be used on lumber thicker than 1-1½" unless it is known to have uniform moisture content throughout its thickness. Thicker stock should be tested with electrodes having 1" penetration, preferably of the insulated type. The insulated pins, making contact only with their uninsulated portion at the tip, have a uniform contact area with the wood, regardless of the pins penetration: therefore, any change in meter readings taken with such pins at different levels of penetration clearly reflect an actual change in moisture content (moisture gradient).

This cannot be accomplished by using non-insulated pins since, with increasing penetration in the wood, the contact area would increase causing a rise in meter readings. This variation is small in the low moisture range and when the moisture is uniform, but it may be quite significant in the medium to high moisture range (15% to 25%) and it is further magnified if a moisture gradient exists.

3. **AVERAGE MOISTURE CONTENT:** When wood is in the process of drying and all of it has been dried below the fiber saturation point, the fibers located at 1/5 of the total thickness from the surface have a moisture content close to the average of the section. Driving the contact pins to a depth of about 1/5 of the thickness of the board gives an indication of the average moisture content of the section.

4. **MOISTURE DISTRIBUTION:** Large differences in moisture content may exist in the same board, especially during drying. Such differences result in significant variations among meter readings. Under these circumstances it serves little purpose to compare meters with oven tests. A moisture meter tends to read the highest moisture content of the wood in the area making contact with the pins, while an oven test gives an indication of the total moisture in the sample tested. Such results show that electrical moisture meters are not necessarily a replacement of the oven tests, but since the meters — through a number of readings — not only show the average moisture content, but also its range, which may be a better measure of the "seasoning" of the wood. The smaller the range, the better the degree of "seasoning".

5. **SPECIES CORRECTION:** Different species of wood have different electrical properties and, as a result, "read" differently at the same moisture content. The moisture detector is calibrated to read the moisture content of Douglas Fir directly. Conversion tables should be consulted when testing other species of wood. Corrections below 10%, for most domestic species, are so small that they can be disregarded.

LABORATORY EQUIPMENT

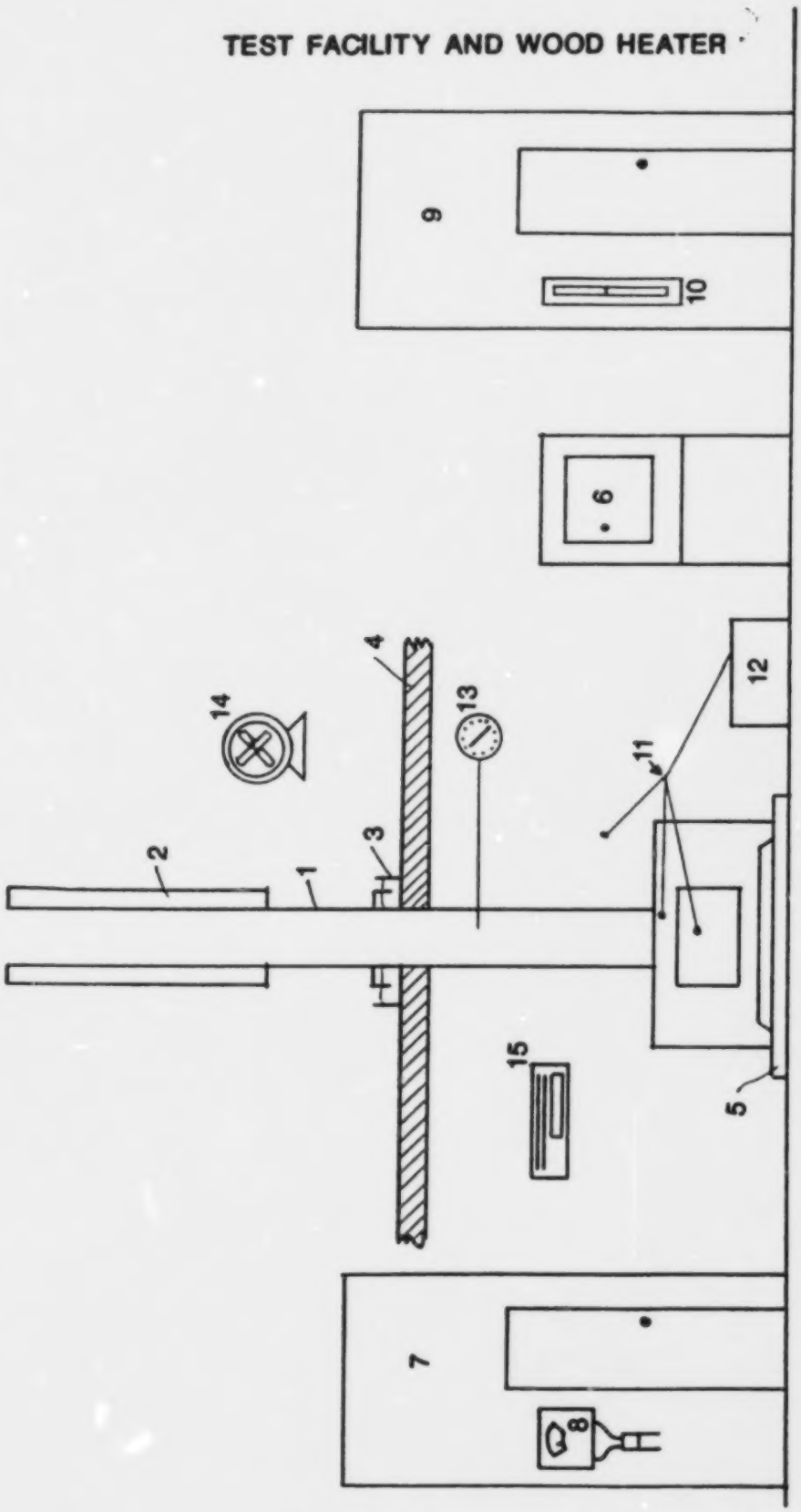
FACILITY AND WOOD HEATER LIST

Item from Figure	Name	Description (Testing conducted in Booth 1)
1	Flue pipe	8 inch diameter single wall steel pipe; black silicate cement sealing compound; zip screw fasteners.
2	Insulated	Security Chimneys or Metalbestos brand solid pack flue pipe chimney; self-locking style.
3	Liquid seal	Optional equipment. Seal system consists of a cylinder with an inner reservoir for mineral oil located below the ceiling of the booth and an outer reservoir for water located above the ceiling of the test booth. The flue pipe attachment floats in the oil reservoir and a cone-shaped flue adapter sets in the water reservoir. Sampling ports and insulated pipe are above the cone.
4	Supports	The liquid seal system supports the flue pipe; the walls and ceiling of the test booth support the seal system. A wire system is used in lieu of the liquid seal.
5	Platform Scale	National Controls Model 5785 with digital readout and tare function, heavy-duty full electronic type, 500 x .05 KG capacity, accuracy of 1/10 of 1% or better.
6	Fuel storage area	Storage box constructed of plywood set above the floor on a steel frame, size 3' x 4' x 10.5'. Pans of water in floor of box provide humidity, box is maintained at facility ambient temperature.
7	Fuel Preparation Area	Separate room with chop and table saws provided to maintain noise level in lab as low as possible. Temperature is same as ambient.
8	Moisture Meter	Delmhorst Instrument Company, Model RC-1C, .25 resolution, accuracy of +/- 2% on range of 20% to saturation, range of 6-80%, 2-pin 26E type; calib.: x-y electromechanical span is set before each use and calibrated against the metal resistance plate @ 12% and 22%.

FACILITY AND WOOD HEATER LIST (CONT.)

Item from Figure	Name	Description
9	Sample Analysis Room	Separate room in facility for all cleanup, desiccation, and weighing of samples. Includes Mettler electronic balance, ambient dryer, and two plexiglass sealed desiccators.
10	Mercury Barometer	Mercury type, Princo Company.
11	Surface and Catalyst Temperature Monitors	Type K thermocouples, bare wire and stainless steel connectors. Readout by automated data logger system with range of -50°F to 1999°F and accuracy of +/- 4.7°F for Booth 1. Readout by Digital Thermometer (Type K) Omega Manufacturing Model 115, resolution of 1%, accuracy of +/- 4.7% at 25° C, range -50 to 1999°F for Booth 2.
12	Data Record	Automated Data Logger Strawberry Tree Company software and hardware, System modified by OMNI staff for testing use in Booth 1. Data is recorded manually for Booth 2.
13	Draft gauge	Magnehelic differential pressure type, Dwyer Instruments, Inc., Model 2000.00, resolution .02 inches H_2O, accuracy of +/- 2% of full scale.
14	Anemometer	Vane type, Dwyer Instruments Inc., Model No. 480, accuracy of +/- 5% of full scale, range 0-100 feet per minute.
15	Humidity gauge	Psychrometer, battery operated wet and dry bulb, mercury filled thermometers.

TEST FACILITY AND WOOD HEATER



011 A

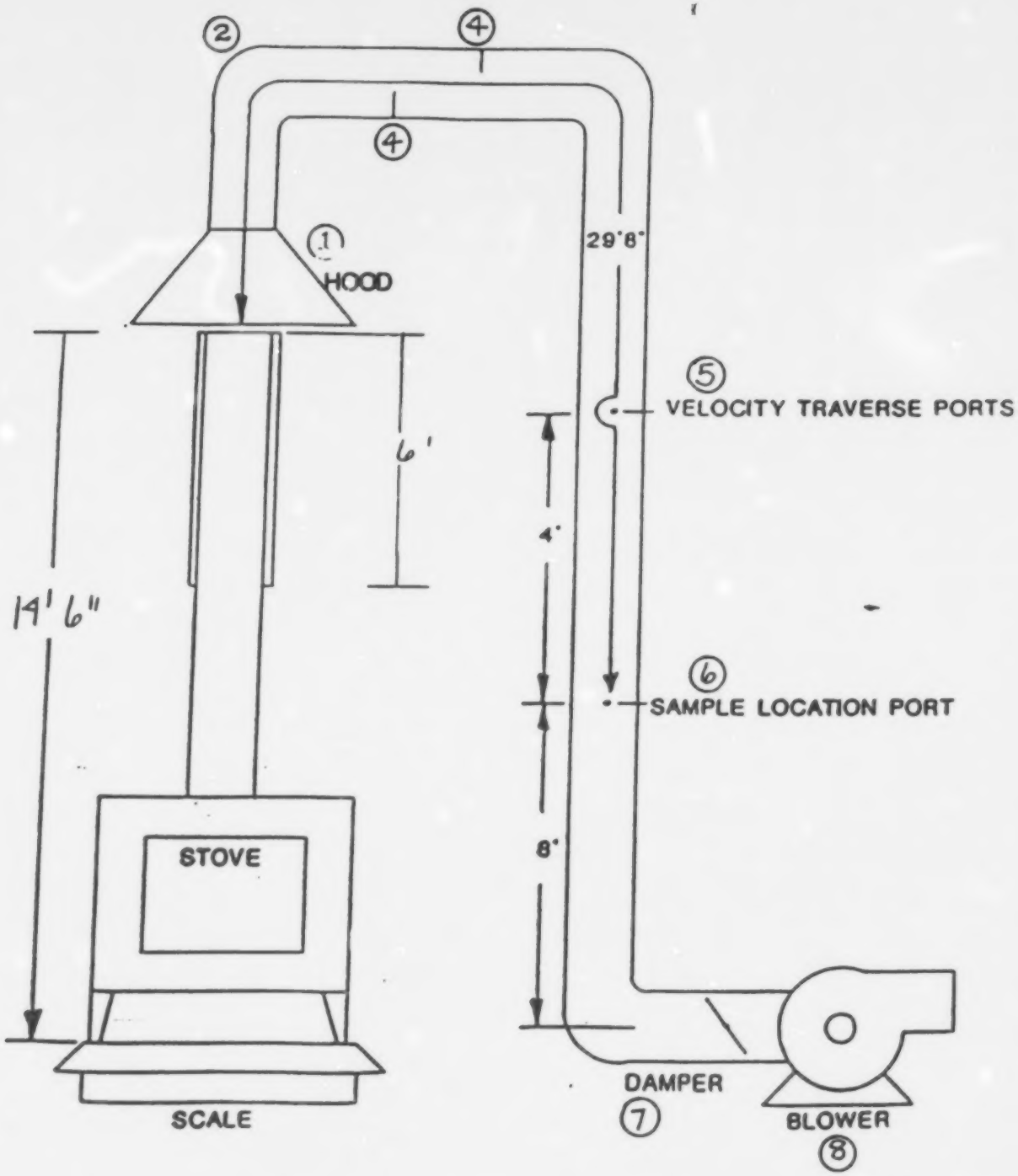
DILUTION TUNNEL EQUIPMENT SPECIFICATIONS

Item from Figure	Name	Description
1	Hood	30 inch square tin metal hood.
2	Tunnel	6" diameter single wall steel pipe, 40 feet total length, two 90° elbows; joints made of black silicate cement, duct tape, and zip screws.
3	Tunnel dimensions	See attached figure.
4	Baffles	Two, cast iron, semi-circular (from 6" diameter damper) see attached diagram for placement, removable.
5	Traverse Points	Ports are located 25' 8" downstream of hood and 8' 9" downstream of second elbow; the 1/8" dia pocket-sized standard pitot tube is inserted in a 3/16" dia hole and is held vertically in place by an arm mounted on the side of the tunnel and secured by a pinch clamp, duct tape is placed at the junction of the tube and tunnel.
6	Sample ports	Located 4' downstream of velocity ports; 1/2" dia hole, duct tape is placed at the junction of the sample train probe and tunnel.
7	Damper	Located ~3' upstream of blower, at a T section of pipe, cast iron.
8	Blower	Dayton Radial Blade, Model 4C217, free air capacity of 2375 CFM at 1725 RPM.
9	Cleaning Materials	Standard chimney brushes.

DILUTION TUNNEL EQUIPMENT

OMNI ENVIRONMENTAL SERVICES, INC.

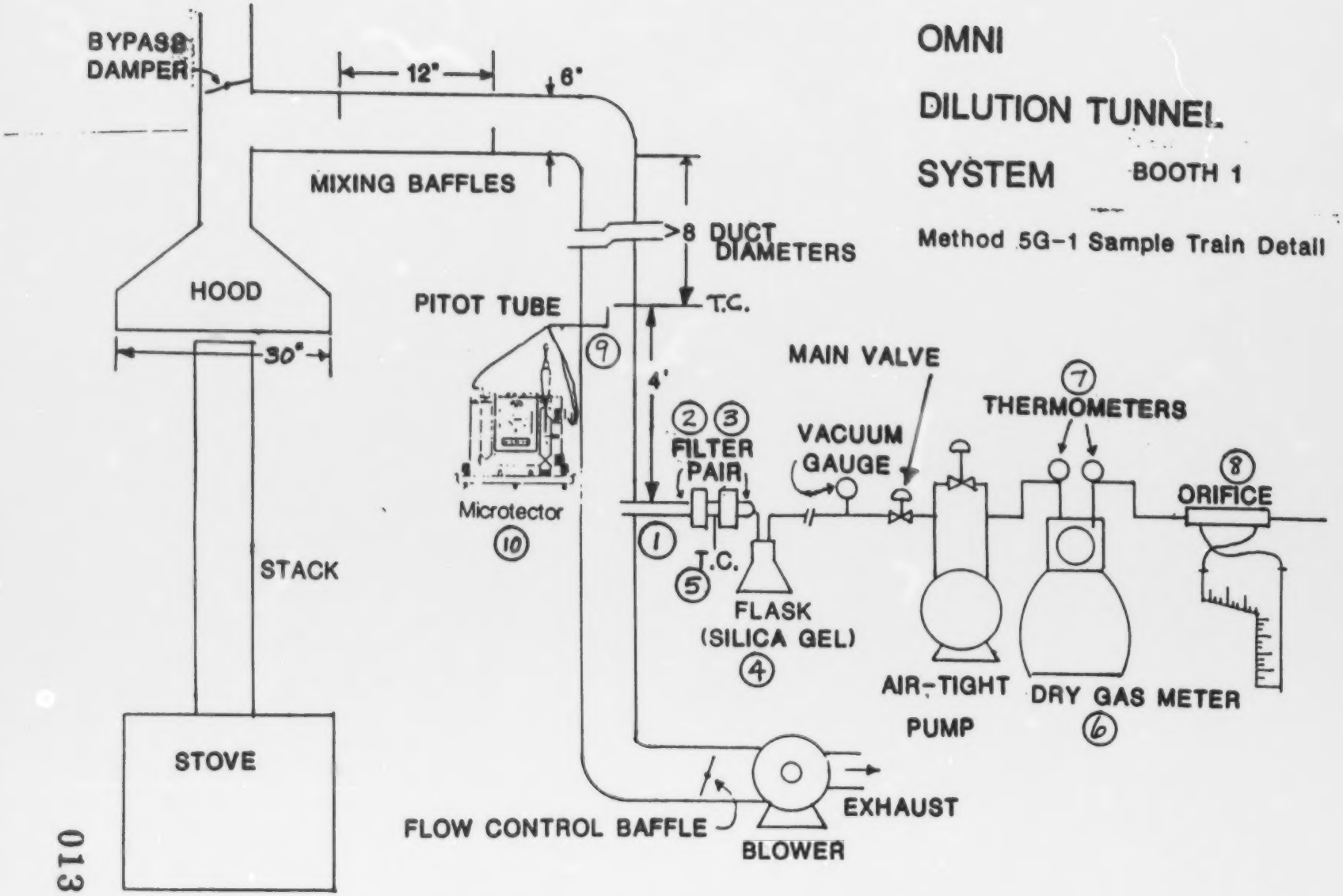
BOOTH 1



012 A

SAMPLING TRAIN METHOD 5G-1

Item from Figure	Name	Description
1	Probe	Stainless steel 3/8" diameter, 24" length, connected with Parker compressions fittings.
2	Filter holder	Front and Back: Teflon material, size to hold 102 mm diameter filter, stainless steel perforated frit, Parker compression fittings, teflon and silicone rubber gaskets.
3	Filter	Front and Back: Gelman Sciences mfr. catalog # 61633; 102 mm (4") diameter; glass fiber without binder, 99.98%DOP efficiency.
4	Dryer	Glass flask with ground glass connectors containing Silica gel - Indicating, 6-16 Mesh, Grade H Type IV.
5	Thermometer (filter)	Thermocouple Type K bare wire, automated data logger readout.
6	Dry Gas Meter	Rockwell M & U Div., Model S-190, range 0-190 CFH, resolution of .001 CF.
7	Thermocouple (dry gas meter)	Thermocouple Type K bare wire, automated data logger readout.
8	Manometer orifice	Dwyer Instruments, Inc. Durablock Inclined-Vertical Model 422-5, range of 0-5" H_2O, bubble level sensitive to 115-125 sec./2 mm, two lines of red gage oil for reading.
9	Pitot	Dwyer Instruments, Inc. Standard pocket-size 1/8" diameter, 6" length, stainless steel.
10	Pitot readout	Dwyer Instruments, Inc. Microtector Portable Electronic Point Gage Model 1430, accuracy +/- .00025" H_2O, range 0 to 2" W.C.


OMNI
DILUTION TUNNEL
SYSTEM
BOOTH 1
Method 5G-1 Sample Train Detail
BYPASS DAMPER
12"
6"
MIXING BAFFLES
>8 DUCT DIAMETERS
HOOD
PITOT TUBE
T.C.
30"
9
4'
MAIN VALVE
7
THERMOMETERS
2 3
FILTER PAIR
VACUUM GAUGE
8
ORIFICE
Microtector
10
1
STACK
T.C.
5
FLASK (SILICA GEL)
4
AIR-TIGHT PUMP
DRY GAS METER
6
STOVE
EXHAUST
FLOW CONTROL BAFFLE
BLOWER
013A

CALIBRATIONS - METHOD 28 AND 5G-1 - SIX-MONTH

Method 28:
- Platform Scale
- Automated Data Logger Thermocouple Readout (5G also)
- Draft Gauge
- Anemometer
- Relative Humidity Gauge

Method 5G:
- Dry Gas Meter
- Calibrator Dry Gas Meter
- Analytical Balance

OMNI

INSTRUMENT NAME SCALE W/METER READOUT (Booth #1)

DESCRIPTION PLATFORM SCALE WITH DIGITAL READOUT + TARE FUNCTION

MANUFACTURER NATIONAL CONTROL, INC

8285 S.W. CIRRUS DRIVE BLDG. 15

Beaverton, OR 97005 PHONE (503) 626-3008

STYLE/MODEL 5785

SCALE FLEX weigh CORP. - FLB-3030 Santa Rosa, Ca. 95401

SAMPLE FLOW RANGE N/A

RESOLUTION 0.1

SENSITIVITY 0.1 lb

ACCURACY ± .1 lb

RANGE 0-1000 lbs

Readout Display Unit: SERIAL # SR42830025; OMNI # OMSE03

SCALE: SERIAL # SEA22; OMNI # OMSE03

* FREQUENCY OF CALIBRATION TESTLY, BEFORE IT'S FIRST USE, AFTER ANY REPAIRS.

CALIBRATOR NATIONAL CONTROL, INC.

SAME AS ABOVE PHONE #

REFERENCE STANDARD NBS

Full multi-point calibration is performed after each repair.

TESTLY = Audited with a Ten pound NBS traceable weight before and after a test.

OMNI

CALIBRATION AND MAINTENANCE RECORD

INSTRUMENT NAME SCALE

MANUFACTURER NATIONAL CONTROL, INC

COMPONENTS REQUIRING CALIBRATION:

Weight READOUT

DESCRIPTION PLATFORM SCALE & DIGITAL READOUT

STYLE/MODEL 5785

FREQUENCY OF CALIBRATION:

meter — SERIAL NO. SR4288025 / OMNI NO. OMSE03

Scale — SERIAL # 85422 / OMNI # OMSE03

Testy. BEFORE IT FIRST USE. CAL. BY FACTORY, AFTER ANY REPAIRS.

COMPONENT CALIBRATED/ SERVICED	DATE	BY	RESULTS (i.e., CORRECTION FACTOR)	DATE OF NEXT CALIBRATION
Scale Readout	3/26/86	NCI	adjustments were made to check out linear	
adapt TO IBM PC	3/26/86	NCI		
Scale repair and rewired and calibrated	1/8/87	Weight-Tronix	Scale check out it good	

015

NATIONAL CONTROLS, INC.

A subsidiary of Weigh-Tronix, Inc.
2320 Airport Blvd. • P.O. Box 1501
Santa Rosa, California 95402-1501
(707) 527-5555 • Telex: 4979910
Facsimile: (707) 579-0180

INVOICE

FOR: IPD/PORTLAND

PLEASE REMIT TO: NATIONAL CONTROLS, INC.
SDS 12-0443
MINNEAPOLIS, MN. 55486

NUMBER	PAGE
146164	1
1/13/88	

BILL TO
OMNI ENVIRONMENTAL SERV
ATTN ACCOUNTS PAYABLE
10950 SW 5TH AVENUE #245
BEAVERTON OR 97005

SHIP TO
OMNI ENVIRONMENTAL SERV 20100
ATTN ACCOUNTS PAYABLE
10950 SW 5TH AVENUE #245
BEAVERTON OR 97005

CUSTOMER NUMBER	SHIP VIA	SALES ORDER NO.	SALESMAN NO.	PURCHASE ORDER NO.	PAYMENT TERMS
1- 6389300		C620438	20100	2027	NET 30 DAYS

ITEM NUMBER	DESCRIPTION		SHIPPED	BACK ORDERED	UNIT PRICE	AMOUNT
	REF: ISD-PORTLAND REPAIR & SERVICE WORK ORDER #62-0438					
999599451	SERVICE/REPAIR 4.5 HOURS	EA	1		202.500	202.50
999599449	P/N 114000149 6 CONDUCTOR SHIELDED LOAD CELL CABLE	FT	20		2.000	40.00
999599447	MILEAGE	EA	18		.600	10.80
999599445	MISC. (SERVICE SUPPLIES)	EA	1		10.000	10.00

RECEIVED JAN 19 1988

	NET SALES AMOUNT		OTHER CHARGES	TAXES	FREIGHT	AMOUNT DUE
	263.30					$ 263.30

THIS ORDER SUBJECT TO THE TERMS AND CONDITIONS ON REVERSE SIDE.

016

OMNI

(Booth # 1)

INSTRUMENT NAME IBM Personnal Computer w/ EPSON PRINTER

DESCRIPTION Computer with Disk Drive /w STRAWBERRY TREE SOFTWARE AND HARDWARE FOR TEMP. AND INTERNAL RELATIVE HUMIDITY READ OUT

MANUFACTURER IBM

PHONE

STYLE/MODEL P/C

SERIAL # 1670154315

OMNI # [redacted] OMSE25

SAMPLE FLOW RANGE NA

RESOLUTION NA

SENSITIVITY NA

ACCURACY NA

RANGE NA

FREQUENCY OF CALIBRATION Weekly, Monthly and Quaterly Semi Annually, AFTER ANY REPAIRS

CALIBRATOR Emissions Personal

PHONE #

REFERENCE STANDARD NBS PORTABLE T/C CALIBRATOR

Weekly = CLEAN + VACUM COMPUTER AND PRINTER (COVER SCREEN WITH COMPUTER COVER WHEN NOT IN USE). TEST T/C CONNECTIONS WITH T/C CALIBRATOR.

Monthly = Calabrate Scale, HC Monitor, + CO CO2 Analizer TO Computer

Quaterly = (Clean disk drive heads AND CORRECTED DISK HEADS.
- Clean Computer inside and out.

OMNI

CALIBRATION AND MAINTENANCE RECORD

INSTRUMENT NAME IBM PC Computer

DESCRIPTION Computer with disk drive and Epson printer w/ STRAWBERRY TREE SOFTWARE AND HARDWARE FOR TEMP AND DIFFERENTIAL READOUT.

MANUFACTURER IBM

STYLE/MODEL PC

SERIAL NO. 1670159150

OMNI NO. OMSE25

COMPONENTS REQUIRING CALIBRATION:

STRAWBERRY TREE HARDWARE (TEMP AND GAS DIFFERENTIAL READOUT.)
IBM DISK DRIVES HEADS.

FREQUENCY OF CALIBRATION:

Weekly, Monthly and Quaterly, Semi Annually.
AFTER ANY REPAIRS.

COMPONENT CALIBRATED/ SERVICED	DATE	BY	RESULTS (i.e., CORRECTION FACTOR)	DATE OF NEXT CALIBRATION
Calibrated T/C Specification readout	8/2/87	SPH	NO ADJUSTMENT	9/2/87
Calibrated T/C six Monthly Cal	6/15/87	SPH	No Adjustment	12/15/87
Calibrated T/C ice and boiling	12/30/87	SPH	No adjustments	6/30/88
Calibrated T/C ice Bath and Boiling	11/4/88	SPH	No Adjustments	5/4/88

018

TEMPERATURE CALIBRATION

OMNI Environmental Services, Inc.

Temperature Monitor Type: IBM PC Data Aq. System
Identification Number: OMSE25

Reference Temperature Monitor Type: Mercury in glass
Identification Number: OMST15/T-9691
Readout Device: Mercury

Calibration Performed by S.W. Ambient Temperature 68
Date 11/4/88 Barometric Pressure 29.79

Reference Point Source	Mercury Temperature of Reference Point °F	Observed Temperature — Temperature Monitor				
		DT Tunnel	s.g. exit	Room	M-4 Meter	* OMST#2 IN OUT
ice Bath	32	31.3	33.5	31.8	34.1	33.3
Boiling H_2O	212	214.4	213.0	213.1	214	211.3

OMST#2 - IS THE SOURCE TEST BOX WE USE FOR M4 STOVE TESTING which includes the DAS METER. S.W.

TEMPERATURE CALIBRATION

OMNI Environmental Services, Inc.

Temperature Monitor Type: IBM PC Data. AQ. System
Identification Number: OMSE25

Reference Temperature Monitor Type: Mercury in glass
Identification Number: OMST15/T-9691
Readout Device: Mercury

Calibration Performed by S. W. Ambient Temperature 66
Date 11/4/88 Barometric Pressure 29.79

Reference Point Source	Mercury Temperature of Reference Point °F	Observed Temperature						
		WB	DB	Hot Box	Exit*	DT Meter	DT* Probe A	B
		Temperature Monitor						
Ice Bath	32	31.3	32.4	n/a	32.1 32.3	33.2	31.3	32.1
Boiling H2O	212	213.0	213.1	n/a	211.9 212.7	214.3	212.4	211.6

* EXIT - includes both umbilical Adapters we use for stove testing for M-4 set up.

* DT PROBE - includes both DT sampling probes we use for stove testing.

OMNI

INSTRUMENT NAME MAGNEHELIC GAGE (Booth #1)

DESCRIPTION Magnehelic Differential Pressure Gage

MANUFACTURER Dwyer Instruments, Inc.

P.O. Box 373

Michigan City, Indiana 46360 PHONE (219) 872-9141

STYLE/MODEL ~~2001-C~~ 2000.00 SERIAL # N/A

OMNI # OMSE[redacted]26

SAMPLE FLOW RANGE N/A

RESOLUTION .02

SENSITIVITY .01

ACCURACY ±2% of full scale

RANGE ~~0 to 1.0 inches water~~ 0TO .25 inches OF WATER

FREQUENCY OF CALIBRATION ~~Monthly,~~ [redacted] Semi Annual Testly

— (instrument is zeroed before each test)

CALIBRATOR Stove Operator

PHONE #

REFERENCE STANDARD Manometer, liquid

OMNI

magnehelic gauge Calibration Data

Date 11/4/88 Calibration by SW

Type 0-25 SN-OMSE20 System used in STOVE DRAFT (BOOTH #1)

Reference STANDARD Liquid Manometer MICROTECTOR	Magnehelic READOUT unit's actual readout	% DEV.		
.018" H_2O	.0175" H_2O	2.7		
.050" H_2O	.050" H_2O	0.0		
.150" H_2O	.1475" H_2O	1.7		

OMAHA

INSTRUMENT NAME VANEOMETER, AIR VELOCITY METER.

DESCRIPTION VANE TYPE VELOCITY METER

MANUFACTURER DWYER INSTRUMENTS, INC.

PO BOX 373,

Michigan, city, IND. PHONE 219-872-9141

STYLE/MODEL NO. 480 SERIAL # ____

CMMI # OMSE32

SAMPLE FLOW RANGE NA

RESOLUTION NA

SENSITIVITY ± 5%

ACCURACY ± 5% full scale

RANGE 0 - 100 FPM

FREQUENCY OF CALIBRATION semi annually, after each repair.

CALIBRATOR Emmission Testers

PHONE #

REFERENCE STANDARD new calibrated vanes from the factory.

OMNI

CALIBRATION AND MAINTENANCE RECORD

INSTRUMENT NAME Vancometer

MANUFACTURER Dwyer

COMPONENTS REQUIRING CALIBRATION:

VANE.

DESCRIPTION VANE Type, AIR VELOCITY METER.

STYLE/MODEL NO. 480 SERIAL NO.

FREQUENCY OF CALIBRATION: OMNI NO. OMSE32

Semi Annually, AFTER ALL repairs.

COMPONENT CALIBRATED/ SERVICED	DATE	BY	RESULTS (i.e., CORRECTION FACTOR)	DATE OF NEXT CALIBRATION
VANE	7/1/87	SJW	INSTALLED NEW VANE FROM FACTORY	8/1/88
VANE	1/8/88	SJW	replaced VANE, NEW VANE FROM FACTORY	7/8/88
VANE	11/4/88	SW.	replaced VANE with new VANE from factory	6/8/88

024

OMNI

INSTRUMENT NAME GAS METER (USED IN DT#1 MSG sampler) Booth #1

DESCRIPTION Singer Dry Test Meter

MANUFACTURER Singer--American Meter Division

13500 Philomont Ave.

Philadelphia, PA 19116 PHONE (215) 673-2100

STYLE/MODEL DTM 115-1 SERIAL # K168339

OMNI # OMSE01

SAMPLE FLOW RANGE 0-115 CFH

RESOLUTION .001

SENSITIVITY .0005

ACCURACY NA

RANGE N/A

FREQUENCY OF CALIBRATION Semi Annually, Post Test Series

After any repair.

CALIBRATOR Emissions Tester

PHONE #

REFERENCE STANDARD Calibration Meter

NOTE: This meter is used in lieu of the built-in meter in the Napp Stack Sampler Control box.

CALIBRATION DATA SHEET
METER BOX GAS METER AGAINST A CALIBRATION DRY GAS METER

Calibration Meter Id.: 93K671568 Box Meter Id.: [illegible] OMSE01
Date: 10-17-88 Barometric Pressure: 30.20
Yds (Cal. meter coefficient) .987
Orifice leak check: OK cal. by: S. DURHAM

Run #	1	2	3	4	5
Cal. Meter Vol. Beg. (V_{ds})	226.900	234.200	241.900	249.700	257.700
Cal. Meter Vol. End	233.972	241.683	249.034	257.281	265.328
Cal. Meter Vol. Dif.	7.072	7.483	7.134	7.581	7.628
Box Meter Vol. Beg. (V_s)	117.6701	125.119	132.918	140.820	148.931
Box Meter Vol. End	124.881	132.697	140.142	148.508	156.667
Box Meter Vol. Dif.	7.180	7.578	7.224	7.688	7.736
Cal. Meter Temp. (F) (t_{ds})	54	59	60	61	62
Box Meter Temp. (F) (t_d)	61	61	62	63	64
Time (mins.) (θ)	20:00	21:00	20:00	15:00	15:00
Δ H	.30	.30	.30	.60	.60
Δ H@	1.337	1.315	1.316	1.314	1.300
Box Meter Coeff. (Y_d)	0.975	0.978	0.978	0.976	0.976
CFM					

Comments: _____

Where: Delta H@ = Orifice pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in. H_2O. Tolerance +/- 0.15.

$$Y_d = Y_{ds} \times \frac{Vds}{V_d} \times \frac{(Td + 460)}{(T_{ds} + 460)} \times \frac{Pb}{(P_b + \Delta H/13.6)}$$

$$Q = 17.65 \times \frac{Pb}{(t_{ds} + 460)} \times \frac{Vds}{\theta}$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \times \left| \frac{(tds + 460)\ \theta}{(Y_d \times V_{ds})} \right|^2$$

SE.046

CALIBRATION DATA SHEET
METER BOX GAS METER AGAINST A CALIBRATION DRY GAS METER

Calibration Meter Id.: 83K671568 Box Meter Id.: ~~83K671568~~ OMSE01
Date: 10-17-88 Barometric Pressure: 30.20
Yds (Cal. meter coefficient) .987
Orifice leak check: _____ cal. by: S. DURHAM

Run #	1	2	3	4	5
Cal. Meter Vol. Beg. (V_{ds})	265.700	274.500	283.000	289.600	
Cal. Meter Vol. End	273.413	282.581	289.180	308.267	
Cal. Meter Vol. Dif.	7.713	8.081	6.180	18.667	
Box Meter Vol. Beg. (V_s)	158.048	165.976	174602	181.302	
Box Meter Vol. End	164869	174.173	180.870	200.245	
Box Meter Vol. Dif.	7.821	8.197	6.268	18.943	
Cal. Meter Temp. (F) (t_{ds})	62	62	62	62	
Box Meter Temp. (F) (t_d)	65	65	67	67	
Time (mins.) (θ)	15:10	13:00	10:00	30:07	
Δ H	.60	.90	.90	.90	
Δ H@	1.297	1.303	1.313	1.305	Avg = 1.311
Box Meter Coeff. (Y_d)	0.978	0.976	0.980	0.980	Avg = 0.977
CFM					

Comments: Booth 1 Dilution Tunnel (SG) Meter Calibration (6 Month)

Where: Delta H@ = Orifice pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in. H_2O. Tolerance +/- 0.15.

$$Y_d = Y_{ds} \times \frac{Vds \times}{V_d} \quad \frac{(Td + 460)}{(T_{ds} + 460)} \times \frac{Pb}{(P_b + \Delta H/13.6)}$$

$$Q = 17.65 \times \frac{Pb}{(t_{ds} + 460)} \times \frac{Vds}{\theta}$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \times \left| \frac{(tds + 460)\ \theta}{(Y_{di} \times V_{ds})} \right|^2$$

SE.046

OMNI

INSTRUMENT NAME Gas Meter (For Use With Dilution Tunnel #2) Booth #2

DESCRIPTION Singer Dry Test Meter

MANUFACTURER Singer American Meter Division

13500 Philomont Avenue

Philadelphia, PA 19116 PHONE 215/673-2100

STYLE/MODEL American Gas Sampling Test Meter SERIAL # 85MI79534

OMNI # OMSE05

SAMPLE FLOW RANGE 0-130 CFH

RESOLUTION .001

SENSITIVITY .0005

ACCURACY N/A

RANGE N/A

FREQUENCY OF CALIBRATION Semi Annually, Post Test Series, AFTER ANY REPAIRS.

CALIBRATOR Emission Tester

PHONE #

REFERENCE STANDARD Calibration Meter

028

CALIBRATION DATA SHEET

METER BOX GAS METER AGAINST A CALIBRATION DRY GAS METER

SN-83K671568

Calibration Meter Id.: OMSE19 Box Meter Id.: OMSE05

Date: 10-14-88 Barometric Pressure: 30.00

Yds (Cal. meter coefficient) ~~.982~~ c.o. 0.987

Orifice leak check: good cal. by: S. DURHAM

Run #	1	2	3	4	5
Cal. Meter Vol. Beg.(V_{ds})	150.500	157.800	165.500	184.200	189.800
Cal. Meter Vol. End	157.566	165.026	172.655	189.122	194.825
Cal. Meter Vol. Dif.	7.066	7.226	7.155	4.922	5.0250
Box Meter Vol. Beg. (V_s)	580.196	587.619	595.473	614.615	620.360
Box Meter Vol. End	587.374	594.987	602.796	619.760	625.505
Box Meter Vol. Dif.	7.178	7.368	7.323	5.145	5.145
Cal. Meter Temp. (F) (t_{ds})	62	62	63	63	64
Box Meter Temp. (F) (t_d)	65	69	69	69	68
Time (mins.) (θ)	20:00	20:~~00~~ 17	20:00	10:00	10:00
Δ H	.30	.30	.30	.60	.60
Δ H@	1.353	1.321	1.337	1.389	1.340
Box Meter Coeff. (Y_d)	0.977	0.980	0.975	0.954	0.970
CFM					

Comments: VAC. @ 2.0" Hg. Booth 2 6-Month Dilution Tunnel (5G) Meter Calibration

Where: Delta H@ = Orifice pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in. H_2O. Tolerance +/- 0.15.

$$Y_d = Y_{ds} \times \frac{Vds}{V_d} \times \frac{(Td + 460)}{(T_{ds} + 460)} \times \frac{Pb}{(P_b + \Delta H/13.6)}$$

$$Q = 17.65 \times \frac{Pb}{(t_{ds} + 460)} \times \frac{Vds}{\theta}$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \times \left| \frac{(tds + 460)\ \theta}{(V_{ds}, V_{ds})} \right|^2$$

SE.046

CALIBRATION DATA SHEET
METER BOX GAS METER AGAINST A CALIBRATION DRY GAS METER

Calibration Meter Id.: S#-83K671568 Box Meter Id.: OMSE05
Date: 10-14-88 Barometric Pressure: 30.00
Yds (Cal. meter coefficient) 0.987
Orifice leak check: _____ cal. by: S. DURHAM

Run #	6 ✱	7 ✱	8 ✱	9 ✱	5	
Cal. Meter Vol. Beg. (V_{ds})	196.300	202.200	208.600 ~~208.258~~	215.300		
Cal. Meter Vol. End	201.321	208.258	214.697	222.228		
Cal. Meter Vol. Dif.	5.0210	6.0580	6.0970	6.928		
Box Meter Vol. Beg. (V_s)	627.016	633.064	639.621	646.483		
Box Meter Vol. End	632.161	639.267	645.863	653.586		
Box Meter Vol. Dif.	5.1450	6.2030	6.2420	7.103		
Cal. Meter Temp. (F) (t_{ds})	64	63	64	64		
Box Meter Temp. (F) (t_d)	68	69	69	~~69~~ 70		
Time (mins.) (θ)	10:00	10:00	10:00	11:21 ~~11:21~~		
Δ H	.60	.90	.90	.90		
Δ H@	1.342	1.375	1.363	1.357	Avg =	1.353
Box Meter Coeff. (Y_d)	0.969	0.973	0.971	0.972	Avg =	0.971
CFM						

Comments: Booth 2 6-Month Calibration of Dilution Tunnel (5K) Meter.

Where: Delta H@ = Orifice pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in. H_2O. Tolerance +/- 0.15.

$$Y_d = Y_{ds} \times \frac{Vds}{V_d} \times \frac{(Td + 460)}{(T_{ds} + 460)} \times \frac{Pb}{(P_b + \Delta H/13.6)}$$

$$Q = 17.65 \times \frac{Pb}{(t_{ds} + 460)} \times \frac{Vds}{\theta}$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \times \left| \frac{(tds + 460)\ \theta}{(Y_{ds} \times V_{ds})} \right|^2$$

SE.046

OMNI

INSTRUMENT NAME Gas Meter (used for calibration)

DESCRIPTION Singer ~~DRY~~ test meter

MANUFACTURER Singer American Meter Division

13500 Philoment Ave.

Philadelphia, PA. 19116 PHONE (215)-673-2100

STYLE/MODEL DTM-115-1 SERIAL # K671568

OMNI # OMSE19

SAMPLE FLOW RANGE .0-115 CFH

RESOLUTION .001

SENSITIVITY .0005

ACCURACY N/A

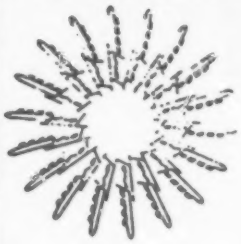
RANGE N/A

FREQUENCY OF CALIBRATION Annually.

CALIBRATOR Emission persons

PHONE #

REFERENCE STANDARD Wet test meter — Precision Wet Test Meter #63126 accuracy of ±0.5%



TEMPRESS MEASUREMENT & CONTROL CORP.

8235 S.W. CIRRUS DR.
BEAVERTON OREGON 97005
(503) 641-1014

REPORT OF CALIBRATION

MFG. Singer-American Meter Div MODEL NO. DT-115 SERIAL NO. 83K671568
REPORT DATE: 10/4/88 RECALIBRATION DATE: 4/4/89
ACCURACY: THE INSTRUMENT HAS A REPORTED LIMIT OF ERROR OF
1 % OF READING () OR FULL SCALE (X) WHEN OPERATED AT THE
AMBIENT CONDITIONS SHOWN ON PAGE 2 OF THIS REPORT.

REPORT PROCEDURE:
THIS REPORT WAS MADE BY DIRECT COMPARISON WITH TEMPRESS LABORATORY TRANSFER STANDARDS, WHICH ARE TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS. REFER TO TEST REPORT NO. _____,
TN 224748
TN 7170608
TN 224033

LABEL ATTACHED TO INSTRUMENT

CALIBRATION REPORT (X)

LIMITED USE ()

DATA TAKEN IS SHOWN ON PAGE 2, AND HAS AND UNCERTAINTY OF
0.5 % OF;

READING ()

FULL SCALE (X)

PRESSURE READING EXPRESSED AT:
UNITED STATES MEAN GRAVITY - 980.000 Gals.
INTERNATIONAL STANDARD GRAVITY - 980.665 Gals.
LOCAL GRAVITY - 980.618 Gals.
(+ - 10 Milligals/CM/Sec2

TEMPRESS
MEASUREMENT AND CONTROL CORP.

BY P. J. Litsark
QUALITY ASSURANCE MANAGER

INSTRUMENT CALIBRATION DATA REPORT

TEMPRESS MEASUREMENT & CONTROL CORP.
6235 SW CIRRUS DRIVE
BEAVERTON, OR 97005

DATE: 10-4-88

ALL INSTRUMENTS USED FOR CALIBRATION HAVE TRACEABILITY TO THE NATIONAL BUREAU OF STANDARDS.

CALIBRATION INST: MASS FLOW METER (TRANSFER STANDARD)
MANUFACTURER SIERRA MODEL NO. 840 SERIAL NO. 7133
ACCURACY % 0.5% F.S. RANGE 0-30,000SCCM 0-1.05944 SCFM ROOM TEMPERATURE 70° F

TEST CONDITIONS:
AMBIENT TEMPERATURE 70° F RELATIVE HUMIDITY 62.5 % BAROMETRIC PRESSURE 29.95 in Hg

INSTRUMENT TO BE CALIBRATED MAKE SINGER-AMERICAN METER DIV
SERIAL NO. 83 K671568 RANGE 0-1 CFM EACH DIVISION 0.01 MFG ACCUR. 1 % FULL SCALE CAT. NO. DT-115

REPORT DATA:

FIVE TEST RUNS WERE MADE USING 0.2, 0.4, 0.6, 0.8, and 1 CFM FLOW RATES. THE READINGS INDICATE THE DISPLAYED VALUE AFTER THE ALLOTTED TIME FOR 5 CF TOTAL ACTUAL FLOW. THE MULTIPLIERS SHOW VALUE READING IS TO BE MULTIPLIED BY TO GET ACTUAL MASS FLOW. NO PRESSURE OR TEMP CORRECTIONS HAVE BEEN MADE TO THE READINGS.

PRESSURE DROP ACROSS METER UNDER TEST AT/CFM =+0.3 to 0.6 in. H_2O

GAS TEMPERATURE = 69.7°F

PRESSURE DROP ACROSS METER UNDER TEST AT 0.2 CFM = +0.1 to 0.3 in H_2O

	STANDARD CU FT	TEST READING	MULIPLIER
1	5.00	4.88	1.025
2	5.00	5.03	0.994
3	5.00	5.13	0.975
4	5.00	5.23	0.956
5	5.00	5.10	0.981
6			
7			
8			
9			
10			

REMARKS SEE TEST SET UP ON FIG-1
REPAIRS NONE

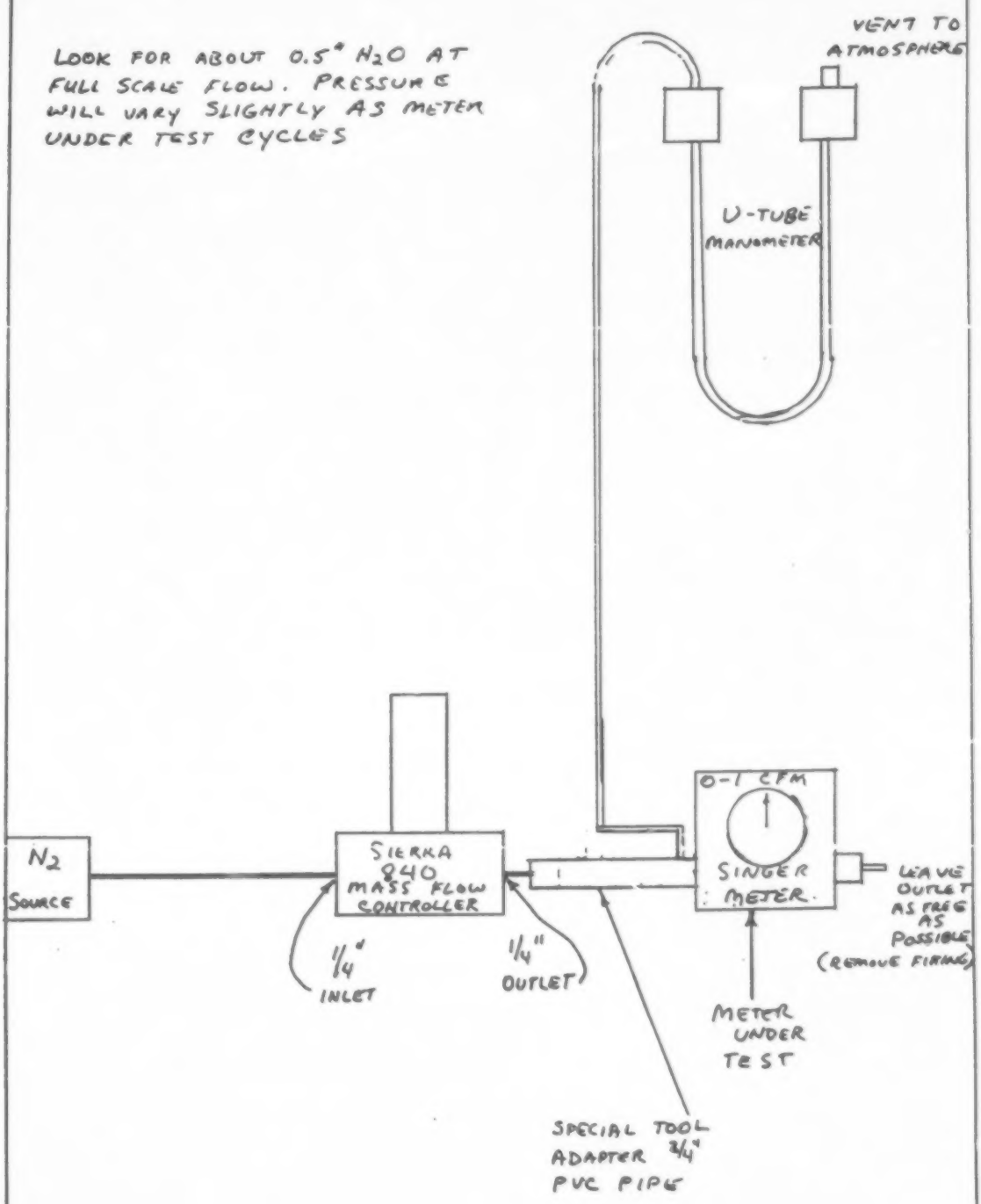
USE LIMITATIONS 0-1 CFM FLOW RATE
CUSTOMER OMNI ENVIRONMENTAL
JOB NO. 091988L2

PROCEDURE NO.
DATE 10/4/88
CALIB. BY STEVE HOHNSTON
INSTRUMENTATION TECH.

033

OMNI ENVIRONMENTAL | 10-5-88 | CALIBRATION SETUP

LOOK FOR ABOUT 0.5" H_2O AT FULL SCALE FLOW. PRESSURE WILL VARY SLIGHTLY AS METER UNDER TEST CYCLES



R. T. Tutmark
Tem Press Measurement & Control Corp 10/6/88

Dry Gas Meter Calibration
S/N 83 K671568

FLOW RATE (CFM)	METER* TEMP. (°F) T_m	METER* ΔH ("H_2O)	METER* VOL (CF) V_d	METER VOL Corr. to STP (DSCF) Q_d	MASS FLOW VOLUME (CF) Q_{cd}	METER CORR. FACTOR Y
.2	69.7	0.2	4.88	4.872	5.0	1.026
.4	69.7	0.2	5.03	5.021	5.0	0.996
.6	69.7	0.3	5.13	5.122	5.0	0.976
.8	69.7	0.4	5.23	5.224	5.0	0.957
1.0	69.7	0.5	5.10	5.095	5.0	0.981
					Avg. =	0.987

$$Q_d = V_d \times \frac{528}{(T_m+460)} \times \frac{\left(P_b + \frac{\Delta H}{13.6}\right)}{P_{b_{STD}}}$$

$$Y = \frac{Q_{cd}}{Q_d}$$

P_b = Barometric Pressure = 29.95 "Hg
$P_{b_{STD}}$ = 29.92 "Hg

* Average of 3 runs

DRAFT

INSTRUMENT NAME Analytical Balance

DESCRIPTION Electronic Analytical Balance

MANUFACTURER Mettler Instrumente AG — Mettler Instrument Co.

CH-8606 Grerlensee, Switzerland — Box 71, Highstown, NJ 08520

PHONE (01) 9412241
(609) 448-3000

STYLE/MODEL AE 200 — SERIAL # E17659

OMNI # OMSE23

SAMPLE FLOW RANGE n/a

RESOLUTION .2 to .4 sec.

SENSITIVITY +/- 2×10^{-6}/°C

ACCURACY 0.1 mg

RANGE 0 - 205 g

FREQUENCY OF CALIBRATION Annually by Service Technician

Each use calibrate by internal calibration function.
and class F .5000 gm weight.

CALIBRATOR

PHONE #

REFERENCE STANDARD Self-calibration and Class F .5 gm calib weight

[illegible] 1 3 1993

QUALITY CONTROL SERVICES
LABORATORY AND METROLOGY EQUIPMENT: SALES AND SERVICE

CERTIFICATE OF CALIBRATION

THE FOLLOWING BALANCES HAVE BEEN SERVICED
BY
QUALITY CONTROL SERVICES, INC.

SERVICE CONSISTS OF ACCURACY TESTS, CLEANING, LUBRICATION, COMPLETE CALIBRATION AND ADJUSTING TO ORIGINAL MANUFACTURERS' SPECIFICATIONS.

ALL TEST WEIGHTS ARE CLASS "S", OR BETTER, AND ARE TRACEABLE TO WEIGHTS CERTIFIED BY THE NATIONAL BUREAU OF STANDARDS CERTIFICATES #737/233864 AND #737/228509.

DATE OF SERVICE	TYPE	MAKE	SERIAL NO.	TECHNICIAN
9/13/88	AE200	METTLER	E17697	C. CAHILL

037

516 S.E. MORRISON, SUITE 213 • P.O. BOX 14831 • PORTLAND, OREGON 97214 • (503) 236-2712

QUALITY CONTROL SERVICES

LABORATORY AND METROLOGY EQUIPMENT SALES AND SERVICE

REPORT OF SERVICE AND CALIBRATION

CUSTOMER [illegible] DATE 9/13/88

ADDRESS [illegible] AMBIENT TEMP [illegible]

BEAVERTON OR 9[illegible] Make [illegible] Model [illegible] S/N [illegible]

Function Tested	As Found	Manufacturer's Tolerance	After Service
Cornerload	±.4 lbs.	±.2 lbs.	±.2 lbs
Optical Range	n/a	n/a	n/a
Optical Range with Tare	n/a	n/a	n/a
Linearity or 50-50	±.1	±.2 AT 100 lbs.	±.2 lbs.
Hysteresis	±1 lbs.	±.1 lbs	±.1 lbs.
Calibration	±.2 lbs.	±.5 lbs.	±.2 lbs

Individual Wt. Readings	As Found	Manufacturer's Tolerance	After Service
100 GRAMS	+.2 lbs	±.3 MILLIGRAMS	±.2 lbs.
200 GRAMS	+.5 lbs.	±.2 lbs.	±.2 lbs
50 GRAMS	±.1 lbs.	±.2 lbs	±.2 lbs.
10 GRAMS	±.1 lbs	±.2 lbs.	±.1 lbs
5 GRAMS	±.1 lbs.	±.2 lbs	±.1 lbs

One or more of the following standards were used as references for this calibration. Their calibration is traceable to the National Reference Standards maintained by the National Bureau of Standards. Our N.B.S. Certificate numbers are 737/233864 and 737/228509.

Manufacturer	Serial Number	Date of Last Calibration	Next Calibration
Rice Lake	5735	1/4/87	1/89
Rice Lake	5736	1/4/87	1/89
Rice Lake	5737	1/4/87	1/89
ice Lake	6023	1/4/87	1/89
roemner	3916	1/4/87	1/89

See attached service/maintenance procedure for complete description of service and calibration.

Technician: [signature] Date: 9/13/88

516 S.E. MORRISON, SUITE 213 • P.O. BOX 14831 • PORTLAND, OREGON 97214 • (503) 236-2712

EXAMPLE CALCULATIONS

(Note: OMNI Environmental Services uses the Lotus 1-2-3 Computer Program for all Method 5G-1 calculations. The program automatically carries 14 decimal points in all calcultions. The numbers on the printout have been rounded for display only.)

The following calculations have been prepared from a sample run — the raw data and printout results are provided for comparison to the example calculated results:

BR - Dry Burn Rate kg/hr
m_n - Total Amount of Particulate Matter Collected
$V_{m(std)}$ - Volume of Gas Sample Corrected to Standard Conditions
v_s - Average Dilution Tunnel Gas Velocity
C_s - Particulate Concentration
Q_{sd} - Average Dilution Tunnel Gas Flow Rate
E - Particulate Emission Rate
E_{adj} - Adjusted PM Emission Rate
PR - Proportional Rate Variation

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT GENERIC STOVE
MODEL
PROJECT # SE000-0
RUN# 1
DATE 1/88
FILTER HOLDER# A

SAMPLE CALCULATIONS

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	0.89	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0005	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	4.051	(GRAMS/HOUR)
ADJUSTED EMISSIONS (Eadj).....	5.8	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	80	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.034	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	103.084	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	73	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	12.38	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	8245.77	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	101.560	(DSCF)
(mn) TOTAL PARTICULATES.....	49.9	(MG)
AVERAGE DELTA H.....	0.55	(INCHES H20)
TOTAL TIME OF TEST.....	204	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

SAMPLE CALCULATIONS

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	GENERIC STOVE
MODEL	
PROJECT #	SE000-0
RUN#	1
DATE	1/88
FILTER HOLDER#	A
GAS METER READING BEGINNING	878.476
GAS METER READING ENDING	981.560
STATIC PRESSURE AVG. PT(IN.H2O)	-0.362
Y=GAS METER CALIB. FACTOR	0.986
WEIGHT OF TOTAL PARTICULATE (MG)	49.9
BAR. PRESSURE BEGIN (in. Hg)	30.15
BAR. PRESSURE MIDDLE (in. Hg)	30.13
BAR. PRESSURE ENDING (in. Hg)	30.10
TOTAL TIME OF TEST(MINUTES)	204
TEST LOAD FUEL WEIGHT (LBS.)	8.3
FUEL MOISTURE % (DRY BASIS)	23.79

AVG BAR. PRESSURE (in. Hg)	30.13
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	73
AVG TEMP. METER DEGREES R	533
AVERAGE DELTA H	0.5500
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	30.1
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	540.3
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	12.383

SAMPLE CALCULATIONS

DILUTION TUNNEL LAB DATA TABLE 2 5E0000 Run 1

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.017	0.550	61.0	95.0	878.4760
10	0.017	0.550	61.0	90.0	883.2400
20	0.017	0.550	64.0	84.0	888.1730
30	0.017	0.550	67.0	83.0	893.1700
40	0.017	0.550	69.0	84.0	898.1650
50	0.017	0.550	71.0	83.0	903.1800
60	0.017	0.550	73.0	84.0	908.2100
70	0.017	0.550	73.0	84.0	913.2600
80	0.017	0.550	74.0	81.0	918.3200
90	0.017	0.550	75.0	82.0	923.3900
100	0.017	0.550	76.0	80.0	928.4600
110	0.017	0.550	75.0	78.0	933.5500
120	0.017	0.550	76.0	77.0	938.6200
130	0.017	0.550	76.0	77.0	943.7000
140	0.017	0.550	76.0	76.0	948.8000
150	0.017	0.550	76.0	76.0	953.9200
160	0.017	0.550	76.0	75.0	958.9800
170	0.017	0.550	76.0	75.0	964.0700
180	0.017	0.550	76.0	75.0	969.1800
190	0.017	0.550	76.0	74.0	974.2700
200	0.017	0.550	77.0	74.0	979.3700
204					981.5600

METHOD SG-1 PROPORTIONAL RATE VARIATION RUN 1 SE000-0

TIME MINUTES	PROPORTIONAL RATE VARIATION CALCULATION
0	98
10	101
20	102
30	101
40	101
50	101
60	101
70	101
80	101
90	101
100	101
110	100
120	100
130	101
140	101
150	100
160	100
170	101
180	100
190	100
200	100

DRY BURN RATE, (BR)

Equation Used

$$BR = \left[\frac{60W_{wd}}{\Theta}\right]\left[\frac{100 - \%M_w}{100}\right]$$

Nomenclature

BR = Dry wood burn rate, kg/hr (lb/hr)

W_{wd} = Total mass of wood burned (wet basis) during the test run, kg (lb)

Θ = Total time of test run, minutes

$\% M_w$ = Average moisture in test fuel charge, wet basis, percent

NOTE: To convert from dry basis to wet basis:

(100) (percent dry reading) ÷ (100 + percent dry reading) = percent moisture wet basis

= 19.218 % wet

$$W_w = \frac{8.3 \text{ lb.s}}{2.205 \text{ kg/lb}}$$

= 3.764 kg

$$BR = \left(\frac{60 \text{ min/hr } (3.764\text{kg})}{204 \text{ minutes}}\right)\left(\frac{100\ \% - 19.22\%}{100\ \%}\right)$$

BR = 0.89 kg/hr (dry basis)

TOTAL AMOUNT OF PARTICULATE MATTER COLLECTED (5G-1)

(m_n)

Equation Used

$$m_n = F_1 + F_2 + R - \left(\frac{m_a V_{aw}}{V_a}\right)$$

Nomenclature

m_n - Total amount of particulate matter collected, mg

F_1 - Particulate matter collected on front filter, mg

F_2 - Particulate matter collected on second filter, mg

R - Residue from evaporated probe and filter holder rinses, mg

m_a - Mass of residue of acetone solvent blank after evaporation, mg

V_{aw} - Volume of acetone used in probe and filter holder rinses, ml

V_a - Volume of acetone blank, ml

Sample Calculation

$$m_n = 39.3\,\text{mg} + 1.5\,\text{mg} + 9.4\,\text{mg} - \left(\frac{(0.3\,\text{mg})(100\,\text{ml})}{(100\,\text{ml})}\right)$$

$m_n = 49.9$ mg

VOLUME OF GAS SAMPLE CORRECTED TO DRY STANDARD CONDITIONS

$\left(V_{m(std)}\right)$

Equation Used

$$V_{m(std)} = K_1 V_m Y\left(\frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{T_m}\right)$$

Nomenclature

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, $dscm^3$ (dscf)

K_1 = 0.3858 $^oK/mm$ Hg for metric units

= 17.64 $^oR/in.$ Hg for English units

V_m = Volume of gas sample as measured by the dry gas meter, dm^3 (dcf)

Y = Dry gas meter calibration factor

P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg)

ΔH = Average pressure differential across the orifice meter (if used), mm H_2O (in. H_2O)

T_m = Absolute average dry gas meter temperature, ^oK (^oR)

Sample Calculation

$$V_{m(std)} = (17.64\,^oR/\text{in. Hg}) \times (103.084\,\text{dcf}) \times (.986) \times \frac{\left(30.13\ \text{in. Hg} + \frac{.55\ \text{in. } H_2O}{13.6\left(\frac{\text{in. } H_2O}{\text{in. Hg}}\right)}\right)}{533\ ^oR}$$

$V_{m(std)}$ = 101.4895 dscf

AVERAGE DILUTION TUNNEL GAS VELOCITY (v_s)

Equation Used

$$v_s = K_p\, C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}}$$

Nomenclature

v_s = Average dilution tunnel gas velocity m/s (ft/s)

K_p = Pitot tube constant;

$34.97 \frac{m}{sec} \left[\frac{(g/g\text{-mole})(mm\ Hg)}{(^oK)\ (mm\ H_2O)}\right]^{1/2}$ for the metric units

$85.49 \frac{ft}{sec} \left[\frac{(lb/lb\text{-mole})(in.\ Hg)}{(^oR)\ (in.\ H_2O)}\right]^{1/2}$ for English units

C_p = Pitot tube coefficient (use 0.99 for standard pitot tube, 0.84 may be used for S-type tubes constructed according to Method 2 specifications)

$(\sqrt{\Delta p})_{avg}$ = Average square root of each individual velocity head (Δp)

Δp = Velocity head dilution tunnel gas, mm H_2O (in. H_2O)

P_{bar} = Barometric pressure at measurement site, mm H_2O (in. Hg)

P_g = Stack static pressure, mm Hg (in. Hg)

P_s = Absolute dilution tunnel gas pressure, mm Hg (in. Hg), or $P_{bar} + P_g$

M_s = Molecular weight of dilution tunnel gas, wet basis, g/g-mole (lb/lb-mole) (may be assumed to be 28.56)

t_s = Dilution tunnel temperature, ^oC (^oF)

T_s = Absolute dilution tunnel temperature, K (^oR), or 273 + t_s for metric units, 460 + t_s for English units

Sample Calculation

$$v_s = 85.49 \frac{ft}{sec} \left[\frac{(lb/lb\text{-}mole)(in.\ Hg)}{(^oR)\ (in.\ H_2O)}\right]^{1/2} \times 0.99$$

$$\times 0.1844\ [in.\ H_2O]^{1/2} \times \sqrt{\frac{540\ ^oR}{(30.13\ in.\ Hg)\ (28.51\ lb/lb\text{-}mole)}}$$

$$v_s = 85.49 \frac{ft}{sec} \left[\frac{(lb/lb\text{-}mole)(in.\ Hg)}{(^oR)\ (in.\ H_2O)}\right]^{1/2} \times 0.99 \times 0.1844\ [in.\ H_2O]^{1/2}$$

$$\times 0.793 \left[\frac{^oR}{(in.\ Hg)\ (lb/lb\text{-}mole)}\right]^{1/2}$$

$$v_s = 12.38\ ft/sec$$

PARTICULATE CONCENTRATION (C_s)

Equation Used

$$C_s = (0.001\ g/mg) \times (m_n/V_{m(std)})$$

Nomenclature

C_s - Concentration of particulate matter in stack gas or dilution tunnel, dry basis, corrected to standard conditions g/dsm^3 (g/dscf)

m_n - Total amount of particulate matter collected in the sampling train, mg

$V_{m(std)}$ - Volume of gas sample measured corrected to dry standard conditions, dsm^3 (dscf)

Sample Calculation

$$C_s = (0.001\ g/mg) \times \frac{49.9\ mg}{101.4895 dscf}$$

$$C_s = 0.00049\ g/dscf$$

AVERAGE DILUTION TUNNEL GAS FLOW RATE (Q_{sd})

Equation Used

$$Q_{sd} = 3600(1 - B_{ws})\, v_s\, A \left(\frac{T_{std}}{T_{s(avg)}}\right)\left(\frac{P_s}{P_{std}}\right)$$

Nomenclature

Q_{sd} - Total gas flow rate corrected to dry standard conditions, dsm^3/hr (dscf/hr)

3600 - Conversion factor seconds per hour

B_{ws} - Water vapor in the dilution tunnel stream, proportion by volume (may be assumed to be 4%)

v_s - Average dilution tunnel gas velocity, m/s (ft/s)

A - Cross-sectional area of dilution tunnel, m^2 (ft^2)

T_{std} - Standard absolute temperature, 293^oK (528^oR)

$(T_s)_{avg}$ - Average absolute dilution tunnel temperature, ^oK (^oR), or $273 + t_s$ for metric units; $460 + t_s$ for English units

t_s - Dilution tunnel temperature, ^oC (^oF)

P_s - Absolute dilution tunnel gas pressure, mm Hg (in. Hg), or $P_{bar} + P_g$

P_{bar} - Barometric pressure at measurement site, mm Hg (in. Hg)

P_g - Dilution tunnel static pressure, mm Hg (in. Hg)

P_{std} - Standard absolute pressure, 760 mm Hg (29.92 in. Hg)

Sample Calculation

$$Q_{sd} = 3600 \frac{sec}{hr} (1\text{-}0.04) \times 12.38 \frac{ft}{sec} \times 0.1963\ ft^2 \times \left(\frac{528^oR}{540^oR}\right) \times \left(\frac{30.13\ in.\ Hg}{29.92\ in.\ Hg}\right)$$

Q_{sd} = 8267.16 dscf/hr

PARTICULATE EMISSION RATE, (E)

Equation Used

$$E = C_s Q_{sd}$$

Nomenclature

E = Particulate emission rate, g/hr

C_s = Concentration of particulate matter in stack gas or dilution tunnel gas, dry basis corrected to standard conditions, g/dscm, (g/dscf)

Q_{sd} = Total gas flow rate, dry basis corrected to standard conditions, dsm³/hr (dscf/hr)

Sample Calculation

E = (0.00049 g/dscf) (8267.16 dscf/hr)

E = 4.05 g/hr

ADJUSTED PM EMISSION RATE, (E_{adj})

Equation Used

$$E_{adj} = 1.82(E)^{0.83}$$

Nomenclature

E_{adj} = Method 5G emission rate adjusted to Method 5H equivalent

E = Particulate emission rate measured using 5G-1 or 5G-3, g/hr (lb/hr)

Sample Calculation

$$E_{adj} = 1.82\ (4.051 g/hr)^{0.83}$$

$$E_{adj} = 5.8\ g/hr$$

NOTE: is raised to the 0.83 power before multiplying by 1.82.

RAW TEST DATA

```
PROGRAM FOR WEIGHTED AVERAGE EMISSIONS CALCULATION (OREGON)

ENTER THE FOLLOWING INFORMATION:
CLIENT#.................? PS342-1
TEST DATE...............? 11-88
STATUS (PRELIM/FINAL)..? F
RUNS....................? 1/2/3/4 W07-2

HOW MANY RUNS DO YOU HAVE? ? 4
RUN A INPUT (BTU/HR),(OAE%),(G/HR)? 24686,70.5,10.38
RUN B INPUT (BTU/HR),(OAE%),(G/HR)? 16392,68.4,11.02
RUN C INPUT (BTU/HR),(OAE%),(G/HR)? 10038,65.5,16.95
RUN D INPUT (BTU/HR),(OAE%),(G/HR)? 34451,62.9,28.47
================================================================================
WEIGHTED AVERAGE EMMISSIONS=    14.07 (G/HR)
WEIGHTED OVERALL EFFICIENCY=    67.16  (%)
================================================================================
WEIGHTING FACTORS:
( 1 )     0.80314     (49.0 %)
( 2 )     0.62005     (37.8 %)
( 3 )     0.19437     (11.9 %)
( 4 )     0.02065     ( 1.3 %)
0
```

FINAL

EPA WEIGHTED EMISSIONS

FINAL

CLIENT # PS342-01
TEST DATE 11-88
STATUS ..... F
RUNS 1/2/3/4 W07-2

CATALYTIC (C) OR NON-CATALYTIC (X).....C
NUMBER OF RUNS 4

BURN RATE (DRY KG/HR)	0.79	
OVERALL EFFICIENCY	72.0	
EMISSIONS (G/HR)	16.95	
CAP (G/HR)	7.78	
WEIGHTING FACTOR	0.568	(32.1 %)
RUN #	3A	

BURN RATE (DRY KG/HR)	1.24	
OVERALL EFFICIENCY	72.0	
EMISSIONS (G/HR)	11.02	
CAP (G/HR)	9.38	
WEIGHTING FACTOR	0.663	(37.5 %)
RUN #	2A	

BURN RATE (DRY KG/HR)	1.81	
OVERALL EFFICIENCY	72.0	
EMISSIONS (G/HR)	10.38	
CAP (G/HR)	11.41	
WEIGHTING FACTOR	0.413	(23.4 %)
RUN #	1	

BURN RATE (DRY KG/HR)	2.83	
OVERALL EFFICIENCY	72.0	
EMISSIONS (G/HR)	28.47	
CAP (G/HR)	15.00	
WEIGHTING FACTOR	0.124	(7.0 %)
RUN #	4A	

WEIGHTED AVERAGE EMISSIONS : 13.99 (G/HR)
WEIGHTED OVERALL EFFICIENCY : 72.00 (%)

EPA STANDARDS:

MANUFACTURED 7/1/88 TO 6/30/90
CATALYTIC 5.5 G/HR NON-CATALYTIC 8.5 G/HR

MANUFACTURED AFTER 7/1/90
CATALYTIC 4.1 G/HR NON-CATALYTIC 7.5 G/HR

RUN 1A

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT E.M.R.
MODEL BLAZE KING KING
PROJECT # PS342-01
RUN# 1A
DATE 10-27-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	1.81	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0010	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	8.149	(GRAMS/HOUR)
ADJUSTED EMISSIONS.....	10.38	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	90	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.036	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	185.330	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	76	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	12.91	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	8375.00	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	178.110	(DSCF)
(mn) TOTAL PARTICULATES.....	173.3	(MG)
AVERAGE DELTA H.....	0.6	(INCHES H20)
TOTAL TIME OF TEST.....	358.50	(MINUTES)

053B

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	E.M.R.
MODEL	BLAZE KING KING
PROJECT #	PS342-01
RUN#	1A
DATE	10-27-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	241.301
GAS METER READING ENDING	426.631
STATIC PRESSURE AVG. PT(IN.H2O)	-0.296
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	173.3
BAR. PRESSURE BEGIN (in. Hg)	29.84
BAR. PRESSURE MIDDLE (in. Hg)	29.85
BAR. PRESSURE ENDING (in. Hg)	29.85
TOTAL TIME OF TEST(MINUTES)	358.50
TEST LOAD FUEL WEIGHT (LBS.)	29.1
FUEL MOISTURE % (DRY BASIS)	21.97

AVG BAR. PRESSURE (in. Hg)	29.85
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	76
AVG TEMP. METER DEGREES R	536
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.8
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	549.5
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	12.909

DILUTION TUNNEL LAB DATA TABLE # RUN 1A ~~or~~ PS342-1 (Booth 1)

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.018	0.600	70.0	79.0	241.3010
10	0.018	0.600	70.0	86.0	246.3500
20	0.018	0.600	72.0	84.0	251.5100
30	0.018	0.600	71.0	89.0	256.6800
40	0.018	0.600	72.0	90.0	261.8000
50	0.018	0.600	73.0	89.0	266.9300
60	0.018	0.600	74.0	87.0	272.2500
70	0.018	0.600	74.0	87.0	277.3800
80	0.018	0.600	74.0	88.0	282.5600
90	0.018	0.600	75.0	92.0	287.7100
100	0.018	0.600	75.0	93.0	292.8300
110	0.018	0.600	76.0	87.0	297.9400
120	0.018	0.600	76.0	86.0	303.0700
130	0.018	0.600	76.0	84.0	308.3500
140	0.018	0.600	76.0	86.0	313.6400
150	0.018	0.600	77.0	90.0	318.9700
160	0.018	0.600	77.0	94.0	324.2000
170	0.018	0.600	77.0	95.0	329.4600
180	0.018	0.600	77.0	89.0	334.8500
190	0.018	0.600	77.0	89.0	339.8300
200	0.018	0.600	78.0	88.0	345.1600
210	0.018	0.600	78.0	88.0	350.3600
220	0.018	0.600	78.0	93.0	355.6700
230	0.018	0.600	78.0	93.0	361.0100
240	0.018	0.600	78.0	97.0	366.9700
250	0.018	0.600	78.0	97.0	371.0500
260	0.018	0.600	78.0	96.0	376.0400
270	0.018	0.600	78.0	94.0	381.1600
280	0.018	0.600	78.0	92.0	386.2900
290	0.018	0.600	78.0	92.0	391.5100
300	0.018	0.600	78.0	88.0	396.5800
310	0.018	0.600	78.0	87.0	401.7000
320	0.018	0.600	78.0	88.0	406.8500
330	0.018	0.600	78.0	89.0	412.0000
340	0.018	0.600	78.0	89.0	417.1100
350	0.018	0.600	78.0	88.0	422.2500
358.3					426.6310

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE E.M.R. WOOD STOVE

RUN NUMBER 1A PROJECT NUMBER PS342-01 SERIAL NUMBER C1106

DATE OF TEST: 10-27-88 STOVE MODEL: K.E.J./W07-2

AVERAGE EFFICIENCIES

COMBUSTION=	HEAT TRANS.=	OVERALL=
85.0 %	83.0 %	70.5 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	62.514	(grams/Kg-wood)	113.225	(grams/hour)

TEST DATA

BURN RATE	4.87	(lb/hr-wet)
BURN RATE	1.81	(kg/hr-dry)
BURN RATE	2.21	(kg/hr-wet)
FUEL MOISTURE	18.01	(% Wet basis)
HEAT OUTPUT	24686.19	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	8.03	(DSCF/minute w/HC)
AIR TO FUEL RATIO	9.11	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	74.10	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	209.24	(Degrees F)
AVERAGE STACK MOISTURE	11.75	(% volume-wet w/HC)
AVERAGE CO2	11.04	(% volume-dry w/HC)
AVERAGE O2	9.13	(% volume-dry w/HC)
AVERAGE CO	0.71	(% volume-dry w/HC)

1 -> 37 00:19:08
0 71.59674 10-31-1988
OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 70.6 %

TABLE 2A
TEST DATA LISTING

CLIENT: E.M.R. RUN NUMBER: 1A DATE OF TEST: 10-27-88

PROJECT NUMBER: PS342-01 MODEL NUMBER: K.E.J./W07-2
FUEL MOISTURE: 21.97 STACK STATIC PRESSURE(in Hg): -3.01555E-03
BAROMETRIC PRESSURE (in Hg): 29.85 ROOM TEMPERATURE (F): 74
STOVE WEIGHT (lbs): 328 AMBIENT MOISTURE CONTENT (%): 1
CHANGE IN STOVE TEMPERATURE(F): 17 FUEL HHV (BTU/lb): 8765
FUEL COMPOSITION: %C= 51 %H 7.3 %O= 41
METHOD 5 RESULTS: % MOISTURE= 11.94 GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 00:36:45

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34211a.DAT

CLIENT: E.M.R. MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/1A RUN NO. 1A

DATE: OCT 27 1988 TECH: SD/JS

FUEL MOIST (%) 21.97 CAT NO. W07-2

FUEL CHARGE (LB) 29.1 COAL BED (LB) 6.8

TEST STARTED: OCT 27 1988 12:36:22 PM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) REFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	29.1	0.0	63	60	70	453	362	244	1342	356	352	626	1267	850	62	-.040
10	27.6	1.5	66	60	71	404	345	234	1277	332	328	791	1170	814	54	-.045
20	26.6	1.0	66	61	71	386	362	230	1911	318	322	838	1199	743	54	-.045
30	25.4	1.2	67	61	71	378	371	232	0	323	329	985	1222	765	55	-.045
40	24.0	1.4	67	61	71	388	373	239	0	337	349	1179	1340	835	57	-.045
50	22.7	1.3	67	62	71	423	373	251	1302	350	363	0	1357	915	57	-.045
60	21.8	0.9	67	62	72	429	368	248	260	338	348	734	1159	815	57	-.045
70	20.9	0.9	67	62	72	398	361	236	0	324	334	706	1109	733	56	-.040
80	19.9	1.0	67	62	72	380	351	231	0	335	342	1168	1172	779	56	-.040
90	18.2	1.7	67	63	72	419	343	253	0	387	397	1389	1521	1026	58	-.040
100	16.2	2.0	67	63	73	494	337	284	1027	428	449	1361	1519	1133	58	-.050
110	15.0	1.2	67	63	73	527	330	288	1071	417	441	982	1679	1077	59	-.045
120	14.4	0.6	67	63	74	515	319	272	0	379	393	717	1418	987	58	-.040
130	14.0	0.4	68	63	74	467	305	250	1041	346	358	637	1225	828	55	-.040
140	13.5	0.5	68	63	74	417	288	231	0	331	336	709	1183	783	55	-.040
150	12.3	1.2	68	63	74	414	278	238	1373	374	376	1595	1503	1008	57	-.045
160	10.6	1.7	69	63	75	499	285	274	0	434	429	1447	1632	1190	59	-.045
170	8.7	1.9	69	63	75	557	297	298	1227	478	461	1385	1510	1177	60	-.045
180	7.6	1.1	69	63	75	553	309	295	0	473	462	1166	1317	1076	59	-.045
190	7.0	0.6	68	63	75	530	311	282	0	443	436	929	1574	1013	56	-.040
200	6.6	0.4	68	63	76	487	302	259	0	402	394	760	1509	946	56	-.040
210	6.3	0.3	69	63	76	457	293	243	0	379	368	710	1379	892	56	-.035
220	5.8	0.5	69	63	76	423	281	233	0	397	361	835	1121	787	54	-.040
230	5.0	0.8	69	63	76	406	276	234	1629	462	384	998	1215	855	54	-.040
240	4.2	0.8	69	63	75	418	282	242	1471	512	414	971	1173	845	55	-.040
250	3.5	0.7	69	63	75	417	297	249	0	527	434	963	1134	816	54	-.040
260	2.9	0.6	69	63	76	414	317	253	567	513	475	1047	1131	792	54	-.045
270	2.5	0.4	70	64	76	401	349	257	265	485	503	912	1060	732	54	-.040
280	2.3	0.2	70	64	75	381	375	254	1076	455	500	840	1012	681	54	-.040
290	2.0	0.3	70	65	76	356	394	243	0	423	480	810	920	621	54	-.035
300	1.9	0.1	70	65	76	333	410	233	0	401	462	771	867	577	54	-.035
310	1.7	0.2	71	66	76	315	417	225	0	387	454	772	878	565	54	-.035
320	1.5	0.2	71	66	76	308	418	220	0	380	460	783	918	573	53	-.035
330	1.2	0.3	71	67	76	309	418	221	0	381	471	803	900	585	53	-.035
340	0.9	0.3	72	67	76	311	422	223	416	388	481	821	919	598	53	-.035
350	0.4	0.5	72	67	76	316	430	226	1239	399	476	825	955	616	53	-.045
360	0.0	0.4	72	67	76	322	431	227	1154	404	471	850	998	645	58	-.045
AVG:					74	416	345	247	1091	400	411	939	1226	829	56	-.041

AVERAGE STARTING SURFACE TEMPERATURE (F): 354
AVERAGE ENDING SURFACE TEMPERATURE (F): 371
TEMPERATURE DIFFERENCE (Te-Ts) 17

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 76.2 AVG. CHANNEL 6: (F) 78.5 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 89.5

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 00:39:06

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34211a.DAT

CLIENT: E.M.R. MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/1A RUN NO. 1A

DATE: OCT 27 1988 TECH: SD/JS

TEST STARTED: OCT 27 1988 12:36:22 PM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	29.1	5.1	15.9	0.11	123	186	100	10.4		
10	27.6	11.1	9.4	0.38	142	197	100	19.3		
20	26.6	10.3	10.5	0.41	140	146	100	19.8		
30	25.4	11.4	9.3	0.45	145	184	100	21.6		
40	24.0	13.1	7.6	0.70	149	162	100	24.5		
50	22.7	11.6	9.2	0.65	149	236	100	22.5		
60	21.8	8.3	12.4	0.41	143	224	100	18.7		
70	20.9	8.3	12.5	0.50	137	205	100	16.3		
80	19.9	11.3	9.6	0.47	145	223	100	20.1		
90	18.2	15.6	4.7	2.44	154	267	100	25.5		
100	16.2	16.5	3.4	3.53	158	277	100	28.0		
110	15.0	14.2	6.5	0.65	152	200	100	24.5		
120	14.4	7.5	13.1	0.15	137	173	100	17.0		
130	14.0	6.8	13.8	0.17	131	182	100	13.8		
140	13.5	8.9	11.9	0.43	126	179	100	11.7		
150	12.3	15.3	4.4	2.01	147	233	100	20.8		
160	10.6	16.5	2.8	3.91	156	281	100	25.2		
170	8.7	16.7	2.8	4.28	145	281	100	18.3		
180	7.6	14.8	5.3	1.41	148	222	100	22.3		
190	7.0	10.6	9.9	0.09	137	202	100	16.2		
200	6.6	9.4	11.0	0.17	133	190	100	14.8		
210	6.3	8.9	11.3	0.21	172	192	100	42.6		
220	5.8	11.4	9.0	0.31	135	216	100	14.8		
230	5.0	12.8	6.7	0.35	137	232	100	15.2		
240	4.2	13.1	7.7	0.34	137	240	100	14.9		
250	3.5	12.8	8.1	0.28	138	241	100	15.6		
260	2.9	12.3	8.2	0.24	138	228	100	12.2		
270	2.5	11.2	9.5	0.19	132	221	100	13.4		
280	2.3	10.4	10.4	0.19	131	207	100	13.2		
290	2.0	9.3	11.2	0.14	116	190	100	7.8		
300	1.9	9.2	11.4	0.14	112	182	100	6.7		
310	1.7	9.7	11.0	0.19	126	182	100	11.7		
320	1.5	10.1	10.7	0.25	116	185	100	7.8		
330	1.2	10.7	10.1	0.19	137	193	100	16.6		
340	0.9	10.7	10.1	0.25	117	196	100	7.8		
350	0.4	10.3	10.7	0.32	108	189	100	5.4		
360	0.0	10.4	10.6	0.37	112	198	100	6.2		

AVERAGE CO2(%): 11.25
AVERAGE CO(%): .737
AVERAGE O2(%): 9.270001
AVERAGE HE(%): 100

FUEL DATA

OMNI

Client/Model EMR Blaze King / KJ Project # PS342-01

Date 10-27-88 Test Crew SD/JS Run # 1

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)-12% Actual Reading 12.25

Cal Value(2)-22% Actual Reading 21.75

Piece	Length		Readings			Type
1	8 ft	21.75	22.00	21.50		2x4
2	___ ft					
3	___ ft					

Length of cut pieces: 7 inches

Time (clock) : _____ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 0 4 X 4 6

CALCULATED LOAD WEIGHT: 30.1 ACTUAL LOAD WEIGHT: 0 (2 X 4)

29.1 (4 x 4)

FUEL PIECE LENGTH: 18.5" 29.1 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	20.25	19.75	19.75	4x4
2	21.75	22.00	22.75	4x4
3	19.50	19.25	19.75	4x4
4	22.75	23.75	23.25	4x4
5	23.00	23.50	22.75	4x4
6	24.25	23.75	23.75	4x4
7				
8				
9				
10				

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 21.97

Time (clock): _____ Room Temp. (F) 60 Initials JS

OMNI-SE.006

OMNI

RUN NOTES

Client/Model EMR / Diaz King/KET Project # PS342-01

Date 10/27/88 Test Crew SD/JS Run # 1A

PREBURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:

SECONDARY: fixed

TERTIARY: fixed

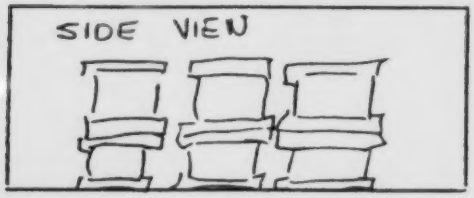
FAN: High

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY SECDRY TERTRY	FAN SETTNG CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@34			10.0lbs.		x	
@50	Primary air set to test setting from full high					
@103			9.2lbs		x	
@147					x	

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)

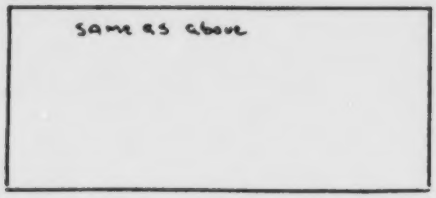


START-UP PROCEDURES:

BYPASS: open 1min 20sec
FUEL LOADING DOOR: closed 1min 20sec
PRIMARY AIR: on high for 5min then slowly set to test setting
OTHER:

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:



SECONDARY: fixed

TERTIARY: fixed

FAN: High

OMNI-SE.004

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 00:26:51

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34211a.DAT

CLIENT: E.M.R.	MODEL NO. BLAZE KING KING
PROJECT NO. PS342-1/1A	RUN NO. 1A
DATE: OCT 27 1988	TECH: SD/JS
FUEL MOIST (%) 21.97	CAT NO. W07-2
TOTAL PREBURN TIME (MIN) 184	LAST PREBURN WT (LB) 6.9

PRE BURN STARTED: OCT 27 1988 02:04:09 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	9.5	0.0	57	57	61	250	163	183	0	381	350	1080	1288	846	56	-.050
10	8.0	1.5	57	58	61	304	197	211	0	418	407	1127	1408	947	56	-.050
20	7.1	0.9	58	58	61	355	220	234	0	458	443	975	1345	1020	56	-.050
30	5.0	2.1	57	57	61	462	266	275	0	543	491	1072	1495	1136	56	-.055
40	3.5	1.5	56	56	62	520	308	304	0	588	531	1208	1413	1079	56	-.055
50	11.9	-8.4	56	57	64	502	344	312	1849	555	534	1040	1348	991	94	-.060
60	10.5	1.4	57	57	65	509	388	303	1618	497	490	748	1372	971	60	-.045
70	9.7	0.8	57	57	66	397	394	236	0	357	355	483	1041	690	60	-.035
80	8.8	0.9	58	58	66	348	375	223	1657	327	336	515	720	514	61	-.050
90	7.2	1.6	58	58	67	327	381	232	128	367	390	898	1207	852	61	-.045
100	5.6	1.6	59	58	68	418	409	265	1616	452	454	898	1436	1003	61	-.045
110	13.9	-8.3	59	58	69	457	417	271	1737	397	396	667	1741	1102	61	-.045
120	13.2	0.7	60	59	69	503	404	261	0	343	344	531	1478	1028	62	-.045
130	12.5	0.7	60	59	69	447	382	233	243	309	307	445	1138	777	61	-.040
140	11.5	1.0	60	59	69	412	365	229	1899	315	303	610	1248	988	61	-.045
150	9.2	2.3	60	60	69	456	356	261	1922	369	379	965	1380	1065	62	-.060
160	8.0	1.2	61	60	70	497	366	272	1509	404	415	959	1497	1038	62	-.045
170	7.5	0.5	62	60	70	488	376	267	1782	389	389	740	1525	971	62	-.040
180	7.0	0.5	63	60	70	464	366	249	0	363	359	651	1415	908	62	-.040
190	6.9	0.1	63	60	70	453	362	244	1342	356	352	626	1267	850	62	-.040

OMNI

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMR Model: BK King

Client # : PS342-01 Run #: ~~Booth 1~~ 1A W07-2

Prepared By: PK Date. 10/27/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 96468 mg - Tare 96462.3 mg
- Blank (.001 mg/ml) (115 ml acetone) = 6.4 mg

B. Front Filter catch: Filter # H064

Final 728.7 mg - Tare 568.0 mg = 160.7 mg

C. Back Filter catch: Filter # H063

Final 571.9 mg - Tare 565.7 mg = 6.2 mg

D. Total particulate catch (A + B + C) = 173.3 mg

OMNI-AS.003

RUN 2A

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT EMRI
MODEL W07-2/BK KING
PROJECT # PS342-1
RUN# 2A
DATE 11-1-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	1.24	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)	0.0009	(GRAMS/DSCF)
PARTICULATE EMISSION RATE	8.754	(GRAMS/HOUR)
ADJUSTED EMISSIONS	11.02	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE	67	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA	0.044	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	273.258	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE	73	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL	13.91	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	9398.22	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	263.896	(DSCF)
(mn) TOTAL PARTICULATES	245.8	(MG)
AVERAGE DELTA H	0.6	(INCHES H20)
TOTAL TIME OF TEST	525.17	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	EMRI
MODEL	W07-2/BK KING
PROJECT #	PS342-1
RUN#	2A
DATE	11-1-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	745.354
GAS METER READING ENDING	1018.612
STATIC PRESSURE AVG. PT(IN.H2O)	-0.296
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	245.8
BAR. PRESSURE BEGIN (in. Hg)	29.80
BAR. PRESSURE MIDDLE (in. Hg)	29.82
BAR. PRESSURE ENDING (in. Hg)	29.83
TOTAL TIME OF TEST(MINUTES)	525.17
TEST LOAD FUEL WEIGHT (LBS.)	28.7
FUEL MOISTURE % (DRY BASIS)	20.01

AVG BAR. PRESSURE (in. Hg)	29.82
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	73
AVG TEMP. METER DEGREES R	533
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.8
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	527.2
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	13.910

DILUTION TUNNEL LAB DATA TABLE 2 RUN 2A BOOTH 1 PS342-01

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.019	0.600	68.0	64.0	745.3540
10	0.019	0.600	68.0	65.0	750.3300
20	0.019	0.600	69.0	65.0	755.3100
30	0.019	0.600	69.0	64.0	760.4500
40	0.022	0.600	70.0	64.0	765.5990
50	0.022	0.600	71.0	64.0	770.8300
60	0.022	0.600	71.0	64.0	775.9800
70	0.022	0.600	72.0	64.0	780.1500
80	0.022	0.600	72.0	64.0	786.3900
90	0.022	0.600	72.0	64.0	791.6500
100	0.022	0.600	72.0	64.0	796.5900
110	0.022	0.600	72.0	65.0	802.2100
120	0.022	0.600	72.0	65.0	807.3400
130	0.022	0.600	73.0	65.0	812.6300
140	0.022	0.600	73.0	65.0	817.9700
150	0.022	0.600	73.0	65.0	823.1800
160	0.022	0.600	73.0	65.0	828.4500
170	0.022	0.600	73.0	65.0	833.5600
180	0.022	0.600	71.0	65.0	839.0500
190	0.022	0.600	68.0	62.0	844.0000
200	0.022	0.600	72.0	68.0	849.2300
210	0.022	0.600	72.0	67.0	854.4400
220	0.022	0.600	72.0	67.0	859.8100
230	0.022	0.600	72.0	67.0	865.0000
240	0.022	0.600	73.0	67.0	870.1300
250	0.022	0.600	73.0	68.0	875.2900
260	0.022	0.600	74.0	68.0	880.4800
270	0.022	0.600	74.0	69.0	885.6800
280	0.022	0.600	74.0	69.0	891.0400
290	0.022	0.600	74.0	69.0	896.1000
300	0.022	0.600	74.0	69.0	901.3800
310	0.022	0.600	74.0	69.0	906.6200
320	0.022	0.600	75.0	69.0	911.7800
330	0.022	0.600	74.0	69.0	916.9900
340	0.022	0.600	74.0	68.0	922.2800
350	0.022	0.600	74.0	68.0	927.4500
360	0.022	0.600	74.0	68.0	933.2500
370	0.022	0.600	74.0	69.0	937.9000
380	0.022	0.600	74.0	69.0	942.9000
390	0.022	0.600	74.0	69.0	948.3000
400	0.022	0.600	75.0	69.0	953.4900
410	0.022	0.600	75.0	69.0	958.7900
420	0.022	0.600	75.0	69.0	963.7800
430	0.022	0.600	74.0	69.0	968.9800
440	0.022	0.600	75.0	69.0	974.1900
450	0.022	0.600	75.0	69.0	979.3900
460	0.022	0.600	75.0	70.0	984.5900
470	0.022	0.600	75.0	70.0	989.9500
480	0.022	0.600	75.0	70.0	994.9800
490	0.022	0.600	74.0	70.0	1000.4600
500	0.022	0.600	74.0	70.0	1005.3800
510	0.022	0.600	74.0	71.0	1010.5900

DILUTION TUNNEL LAB DATA TABLE 2 RUN 2A BOOTH 1 PS342-01

520	0.022	0.600	74.0	70.0	1015.8300
525.167					1018.6120

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE EMRI WOOD STOVE

RUN NUMBER 2A PROJECT NUMBER PS342-1 SERIAL NUMBER C1106

DATE OF TEST: 11-1-88 STOVE MODEL: W07-2/BK KING

AVERAGE EFFICIENCIES

COMBUSTION= 83.5 %	HEAT TRANS.= 82.0 %	OVERALL= 68.4 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	72.606	(grams/Kg-wood)	89.982	(grams/hour)

TEST DATA

BURN RATE	3.28	(lb/hr-wet)
BURN RATE	1.24	(kg/hr-dry)
BURN RATE	1.49	(kg/hr-wet)
FUEL MOISTURE	16.67	(% Wet basis)
HEAT OUTPUT	16392.25	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	6.59	(DSCF/minute w/HC)
AIR TO FUEL RATIO	10.94	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	112.60	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	204.11	(Degrees F)
AVERAGE STACK MOISTURE	10.09	(% volume-wet w/HC)
AVERAGE CO2	8.98	(% volume-dry w/HC)
AVERAGE O2	11.33	(% volume-dry w/HC)
AVERAGE CO	0.69	(% volume-dry w/HC)

1 -) 54 07:32:11

0 69.60233 11-07-1988

OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 68.5 %

TABLE 2A
TEST DATA LISTING

CLIENT: EMRI RUN NUMBER: 2A DATE OF TEST: 11-1-88

PROJECT NUMBER: PS342-1
FUEL MOISTURE: 20.01
-2.42715E-03
BAROMETRIC PRESSURE (in Hg): 29.82
STOVE WEIGHT (lbs): 328
CHANGE IN STOVE TEMPERATURE(F): 19
FUEL COMPOSITION: %C= 51 %H 7.3
METHOD 5 RESULTS: % MOISTURE= 10.24

MODEL NUMBER: W07-2/BK KING
STACK STATIC PRESSURE(in Hg):

ROOM TEMPERATURE (F): 72
AMBIENT MOISTURE CONTENT (%): 1.5
FUEL HHV (BTU/lb): 8765
%O= 41
GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:03:25

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212a.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/2A — RUN NO. 2A

DATE: NOV 1 1988 — TECH: JS/MF

FUEL MOIST (%) 20.01 — CAT NO. W07-2

FUEL CHARGE (LB) 28.7 — COAL BED (LB) 6.7

TEST STARTED: NOV 1 1988 12:37:48 PM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOI	(23) LEFT	(24) RIGHT	(25) DEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	28.7	0.0	64	60	70	393	381	214	0	309	327	504	1103	655	60	-.035
10	27.6	1.1	64	60	70	353	364	204	0	277	303	475	904	603	52	-.038
20	27.3	0.3	64	61	70	318	359	192	0	251	272	414	709	473	54	-.030
30	27.1	0.2	65	61	70	272	346	176	0	228	249	388	530	399	55	-.030
40	26.8	0.3	65	61	69	234	331	160	0	211	231	347	402	348	56	-.025
50	26.6	0.2	65	61	69	199	312	146	0	197	215	346	356	267	55	-.025
60	26.2	0.4	65	62	68	179	299	138	0	199	213	396	400	254	55	-.025
70	25.4	0.8	65	62	69	175	296	141	0	223	231	467	570	310	55	-.025
80	24.5	0.9	65	62	69	200	303	153	0	243	252	505	1023	476	56	-.030
90	23.6	0.9	65	62	69	238	307	163	0	251	255	498	1165	561	56	-.035
100	22.9	0.7	65	62	69	284	311	173	0	254	256	513	1095	590	57	-.035
110	22.3	0.6	65	63	69	299	311	175	0	252	254	483	981	550	57	-.035
120	21.8	0.5	65	63	69	290	305	172	0	248	251	477	928	521	57	-.030
130	21.3	0.5	66	63	69	282	299	169	0	247	249	479	922	506	57	-.035
140	20.8	0.5	66	63	69	274	289	166	0	246	247	521	988	524	58	-.030
150	20.1	0.7	66	63	69	283	285	169	0	253	252	558	1233	613	58	-.035
160	19.3	0.8	66	63	69	350	284	183	0	278	279	732	1483	782	58	-.035
170	18.3	1.0	66	63	69	393	284	197	0	297	300	639	1467	810	59	-.035
180	17.5	0.8	65	63	69	408	281	201	0	296	296	576	1272	743	59	-.035
190	17.2	0.3	62	61	66	379	276	193	0	281	285	520	990	610	60	-.030
200	16.9	0.3	66	64	73	330	267	183	0	263	270	495	839	510	62	-.030
210	16.7	0.2	67	64	73	289	255	169	0	249	259	496	790	445	63	-.030
220	16.4	0.3	68	64	72	266	242	163	0	250	270	743	1048	553	58	-.030
230	15.6	0.8	69	64	72	303	235	174	0	274	299	843	1354	744	57	-.030
240	14.7	0.9	70	65	72	391	233	196	0	306	321	789	1514	892	57	-.030
250	13.2	1.5	69	65	72	471	233	219	0	354	352	851	1562	1026	58	-.030
260	11.7	1.5	70	65	73	510	232	236	0	388	385	813	1447	1044	58	-.040
270	10.8	0.9	70	65	74	519	231	242	0	377	383	700	1647	1041	59	-.040
280	10.1	0.7	70	65	74	505	226	238	0	364	375	661	1644	937	58	-.040
290	9.7	0.4	70	65	74	479	220	230	0	348	361	613	1546	883	59	-.040
300	9.3	0.4	70	66	74	454	213	219	0	326	337	564	1370	802	59	-.040
310	9.0	0.3	70	66	74	418	207	205	0	308	316	538	1257	703	59	-.040
320	8.7	0.3	70	66	74	385	201	193	0	295	299	521	1162	639	57	-.035
330	8.4	0.3	70	66	74	354	195	181	0	288	285	513	1041	583	56	-.035
340	8.0	0.4	70	66	74	327	190	176	0	311	284	568	1105	589	56	-.035
350	7.5	0.5	70	66	73	329	188	178	0	349	298	636	1183	653	57	-.035
360	6.8	0.7	70	66	74	364	193	190	0	404	326	707	1290	733	58	-.035
370	6.3	0.5	71	67	74	377	197	196	0	413	337	715	1281	726	58	-.035
380	5.8	0.5	70	67	74	382	205	201	0	410	349	716	1238	699	58	-.035
390	5.5	0.3	71	67	75	371	214	200	0	402	349	670	1144	643	58	-.035
400	5.3	0.2	71	67	75	356	221	194	0	381	343	634	1108	604	58	-.035
410	5.1	0.2	71	67	75	338	225	187	0	364	332	613	1059	569	58	-.035
420	4.9	0.2	71	67	75	322	226	182	0	355	325	610	1059	559	58	-.035
430	4.6	0.3	71	67	75	318	226	179	0	358	322	641	1059	564	58	-.035
440	4.3	0.3	71	67	75	315	227	179	0	366	325	653	1079	574	59	-.030
450	3.8	0.5	71	67	75	316	227	183	0	384	339	786	1013	608	60	-.030
460	3.1	0.7	71	67	75	337	232	196	0	440	386	838	1101	671	61	-.040
470	2.3	0.8	71	67	75	375	249	214	0	480	422	873	1138	730	62	-.040
480	1.6	0.7	71	68	76	392	267	224	0	497	442	845	1115	715	62	-.040

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:05:13

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212a.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/2A — RUN NO. 2A

DATE: NOV 1 1988 — TECH: JS/MF

FUEL MOIST (%) 20.01 — CAT NO. W07-2

FUEL CHARGE (LB) 28.7 — COAL BED (LB) 6.7

TEST STARTED: NOV 1 1988 12:37:48 PM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
490	1.1	0.5	72	68	76	394	291	229	0	509	459	923	1097	706	62	-.040
500	0.6	0.5	72	67	77	400	314	237	0	527	484	986	1127	757	63	-.040
510	0.3	0.3	72	68	77	399	347	235	0	497	469	768	1026	629	63	-.040
520	0.1	0.2	72	68	77	360	363	222	0	432	420	669	902	542	62	-.040
530	0.0	0.1	72	68	77	340	362	213	0	405	398	641	867	512	62	-.040
AVG:					72	344	266	192	0	328	317	620	1088	633	58	-.034

AVERAGE STARTING SURFACE TEMPERATURE (F): 325
AVERAGE ENDING SURFACE TEMPERATURE (F): 344
TEMPERATURE DIFFERENCE (Te-Ts) 19

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 73 AVG. CHANNEL 6: (F) 67.1 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 67.3

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:04:18

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212a.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/2A — RUN NO. 2A

DATE: NOV 1 1988 — TECH: JS/MF

TEST STARTED: NOV 1 1988 12:37:48 PM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	28.7	7.9	12.5	0.11	114	179	100	7.6		
10	27.6	7.3	10.7	1.31	135	196	100	15.3		
20	27.3	12.1	6.8	3.54	124	170	100	11.4		
30	27.1	7.0	14.3	0.51	119	155	100	10.1		
40	26.8	4.9	15.6	0.41	116	140	100	9.6		
50	26.6	4.3	15.9	0.78	114	134	100	8.9		
60	26.2	3.9	16.2	0.98	121	144	100	11.0		
70	25.4	4.3	15.3	1.37	133	166	100	15.6		
80	24.5	6.0	13.4	1.77	136	187	100	16.3		
90	23.6	7.8	12.2	1.62	137	197	100	16.4		
100	22.9	8.7	11.8	1.31	134	196	100	14.8		
110	22.3	8.8	12.2	0.92	130	184	100	13.4		
120	21.8	7.0	13.9	0.47	142	178	100	20.0		
130	21.3	6.7	14.1	0.49	123	175	100	10.9		
140	20.8	6.7	14.0	0.57	124	182	100	11.0		
150	20.1	7.5	13.3	0.68	137	195	100	16.4		
160	19.3	10.0	11.0	0.63	140	221	100	17.3		
170	18.3	11.4	9.6	0.66	144	230	100	19.2		
180	17.5	10.6	10.8	0.63	132	202	100	13.9		
190	17.2	8.0	13.4	0.30	121	176	100	9.9		
200	16.9	5.2	15.6	0.16	116	160	100	8.7		
210	16.7	10.1	10.4	0.01	113	154	100	8.0		
220	16.4	6.0	14.5	0.43	120	174	100	9.6		
230	15.6	9.9	10.9	0.35	132	207	100	13.4		
240	14.7	10.8	10.3	0.61	117	250	100	6.0		
250	13.2	12.4	8.3	0.62	153	271	100	23.8		
260	11.7	16.5	3.8	4.00	157	250	100	27.0		
270	10.8	17.0	4.2	4.02	149	233	100	22.1		
280	10.1	15.4	5.9	1.08	141	217	100	18.1		
290	9.7	12.6	8.8	0.18	131	208	100	13.3		
300	9.3	9.5	11.8	0.11	126	193	100	11.6		
310	9.0	7.8	13.2	0.21	122	185	100	10.2		
320	8.7	7.6	13.4	0.20	119	175	100	9.4		
330	8.4	7.2	13.7	0.18	113	172	100	7.5		
340	8.0	7.0	13.7	0.24	144	193	100	20.5		
350	7.5	9.3	11.4	0.46	145	213	100	20.5		
360	6.8	11.1	9.7	0.45	145	233	100	19.9		
370	6.3	11.7	9.2	0.47	127	232	100	10.5		
380	5.8	11.5	9.4	0.44	125	225	100	10.0		
390	5.5	10.8	10.1	0.41	120	209	100	8.5		
400	5.3	9.7	11.2	0.34	114	195	100	7.1		
410	5.1	8.6	12.0	0.32	121	188	100	9.5		
420	4.9	8.1	12.3	0.33	112	185	100	6.7		
430	4.6	8.2	12.1	0.37	112	192	100	6.5		
440	4.3	8.9	11.7	0.45	113	194	100	6.5		
450	3.8	9.1	11.5	0.47	123	252	100	8.4		
460	3.1	12.4	8.5	0.45	157	280	100	26.6		
470	2.3	12.1	8.9	0.38	148	301	100	19.8		
480	1.6	11.7	9.4	0.40	145	294	100	18.1		
490	1.1	12.9	8.0	0.34	140	301	100	14.9		
500	0.6	12.9	8.0	0.28	140	310	100	14.6		
510	0.3	7.4	13.3	0.07	130	207	100	12.6		
520	0.1	6.2	14.0	0.10	120	185	100	9.3		
530	0.0	5.8	14.3	0.11	116	177	100	8.3		

AVERAGE CO2(%): 9.16
AVERAGE CO(%): .709
AVERAGE O2(%): 11.49
AVERAGE HE(%): 100

FUEL DATA

OMNI™

Client/Model EMR Blaze King KEJ Project # PS 342-01

Date 11/1/88 Test Crew JS/SD Run # 2A

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)-12% Actual Reading 12.25

Cal Value(2)-22% Actual Reading 22.00

Piece	Length	Readings			Type
1	8 ft	23.25	23.25	24.50	4x4 2x4
2	8 ft	21.75	22.50	22.50	2x4
3	___ ft	___	___	___	___

Length of cut pieces: ___ inches

Time (clock) : ___ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 Ø 4 X 4 6

CALCULATED LOAD WEIGHT: 30.1 ACTUAL LOAD WEIGHT: Ø (2 X 4)

28.7 (4 x 4)

FUEL PIECE LENGTH: 18.5 28.7 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	19.75	20.25	20.25	4x4
2	21.25	20.50	21.00	4x4
3	20.25	20.00	20.00	4x4
4	19.75	19.50	20.00	4x4
5	20.00	20.25	20.00	4x4
6	19.00	19.25	19.25	4x4
7	___	___	___	___
8	___	___	___	___
9	___	___	___	___
10	___	___	___	___

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 20.01

Time (clock): ___ Room Temp. (F) 60 Initials JS

OMNI-SE.006

OMNI

RUN NOTES

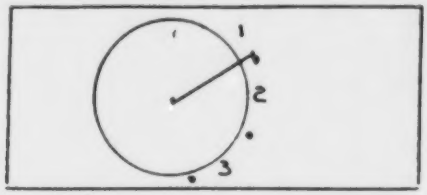
Client/Model EMR Blaze King KC1 Project # PS 342-01

Date 11/1/88 Test Crew JS/SD Run # 2A

PREBURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:



SECONDARY: Fixed

TERTIARY: Fixed

FAN: High

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY SECDRY TERTRY	FAN SETTING CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@ Ø	Primary airon high					
@ 30					X	
@ 50					X	
@ 55	Primary air set at test setting					

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)

START-UP PROCEDURES:

BYPASS: Open to load fuel (1.5 min)
FUEL LOADING DOOR: Loaded in 1.5 min) Closed at 1.5 min.
PRIMARY AIR: Full high for 4.5 min then slowly set to test setting by 5 min.
OTHER: Cat @ 900° @ 5 min.

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY: Same as above

SECONDARY: Fixed

TERTIARY: Fixed

FAN: High

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:02:00

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212a.DAT

CLIENT: EMRI	MODEL NO. BK KING
PROJECT NO. PS342-01/2A	RUN NO. 2A
DATE: NOV 1 1988	TECH: JS/MF
FUEL MOIST (%) 20.01	CAT NO. W07-2
TOTAL PREBURN TIME (MIN) 115	LAST PREBURN WT (LB) 6.7

PRE BURN STARTED: NOV 1 1988 10:42:00 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RH(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	29.2	0.0	60	59	0	405	283	266	0	400	459	744	1147	882	59	-.060
10	25.3	3.9	60	59	0	446	333	267	0	385	422	33	1215	848	59	-.060
20	20.9	4.4	60	59	0	458	390	271	0	404	440	809	1322	925	60	-.060
30	17.4	3.5	60	59	0	488	445	287	0	464	479	921	1429	987	60	-.060
40	13.5	3.9	61	59	0	522	461	312	0	517	513	988	1439	1028	59	-.060
50	11.6	1.9	61	59	0	534	493	317	0	544	543	1010	1490	1032	59	-.060
60	9.2	2.4	61	59	0	554	529	332	0	526	540	913	1521	1037	59	-.055
70	8.5	0.7	62	59	0	541	516	312	0	467	483	774	1583	987	60	-.045
80	8.1	0.4	63	60	0	505	475	280	0	419	431	651	1275	852	60	-.040
90	7.6	0.5	63	60	0	440	445	254	0	375	387	581	1354	754	60	-.040
100	7.2	0.4	63	60	70	423	418	235	0	342	356	545	1418	801	60	-.035
110	6.8	0.4	64	60	70	411	393	223	0	320	337	519	1282	739	61	-.035
120	6.7	0.1	64	60	70	398	384	216	0	311	330	507	1139	677	60	-.035

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMK

Model: BK King/4107-2

Client # : PS342-1

Rm #: 2A Booth 1

Prepared By: PK

Date: 11/1/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 91777.9 mg - Tare 91770.4 mg
- Blank (.001 mg/ml) (125 ml acetone) = 7.4 mg

B. Front Filter catch: Filter # H078

Final 789.0 mg - Tare 559.2 mg = 229.8 mg

C. Back Filter catch: Filter # H077

Final 570.3 mg - Tare 561.7 mg = 8.6 mg

D. Total particulate catch (A + B + C) = 245.8 mg

OMNI-AS.003

RUN 3A

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT E.M.R.
MODEL K.E.J.
PROJECT # PS342-01
RUN# 3A
DATE 11-2-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	0.79	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0018	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	14.708	(GRAMS/HOUR)
ADJUSTED EMISSIONS.....	16.95	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	66	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.034	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	442.946	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	72	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	12.40	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	8291.76	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	423.838	(DSCF)
(mn) TOTAL PARTICULATES.....	751.8	(MG)
AVERAGE DELTA H.....	0.6	(INCHES H20)
TOTAL TIME OF TEST.....	849.50	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	E.M.R.
MODEL	K.E.J.
PROJECT #	PS342-01
RUN#	3A
DATE	11-2-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	19.600
GAS METER READING ENDING	462.546
STATIC PRESSURE AVG. PT(IN.H2O)	-0.336
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	751.8
BAR. PRESSURE BEGIN (in. Hg)	29.50
BAR. PRESSURE MIDDLE (in. Hg)	29.40
BAR. PRESSURE ENDING (in. Hg)	29.53
TOTAL TIME OF TEST(MINUTES)	849.50
TEST LOAD FUEL WEIGHT (LBS.)	29.8
FUEL MOISTURE % (DRY BASIS)	20.4

AVG BAR. PRESSURE (in. Hg)	29.48
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	72
AVG TEMP. METER DEGREES R	532
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.5
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	526.5
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	12.400

DILUTION TUNNEL LAB DATA TABLE 2 RUN 3A BOOTH 1 PS342-01

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.017	0.600	68.0	63.0	19.6000
10	0.017	0.600	68.0	63.0	24.7400
20	0.017	0.600	68.0	63.0	29.8400
30	0.017	0.600	69.0	63.0	34.9700
40	0.017	0.600	69.0	63.0	40.1000
50	0.017	0.600	70.0	63.0	45.2800
60	0.017	0.600	70.0	64.0	50.4600
70	0.017	0.600	70.0	65.0	55.6500
80	0.017	0.600	70.0	65.0	60.8000
90	0.018	0.600	70.0	65.0	65.5000
100	0.018	0.600	71.0	65.0	71.0800
110	0.017	0.600	70.0	65.0	76.3400
120	0.018	0.600	70.0	64.0	81.5200
130	0.017	0.600	70.0	64.0	86.7000
140	0.017	0.600	70.0	64.0	91.8700
150	0.017	0.600	70.0	65.0	97.0500
160	0.017	0.600	71.0	66.0	102.2100
170	0.017	0.600	71.0	66.0	107.3800
180	0.017	0.600	71.0	66.0	112.5600
190	0.017	0.600	72.0	66.0	117.7200
200	0.017	0.600	72.0	66.0	122.9800
210	0.017	0.600	72.0	66.0	128.2100
220	0.017	0.600	72.0	67.0	133.2600
230	0.017	0.600	73.0	67.0	138.4200
240	0.017	0.600	73.0	68.0	143.5900
250	0.017	0.600	73.0	68.0	148.7700
260	0.017	0.600	73.0	69.0	154.9500
270	0.017	0.600	73.0	69.0	159.1500
280	0.017	0.600	73.0	69.0	164.4000
290	0.017	0.600	73.0	69.0	169.6500
300	0.017	0.600	73.0	69.0	174.9000
310	0.017	0.600	74.0	69.0	180.2200
320	0.017	0.600	74.0	68.0	185.3600
330	0.017	0.600	73.0	67.0	190.6000
340	0.017	0.600	73.0	68.0	195.9900
350	0.017	0.600	74.0	69.0	201.1800
360	0.017	0.600	74.0	68.0	206.2500
370	0.017	0.600	73.0	67.0	211.4700
380	0.017	0.600	73.0	67.0	219.9300
390	0.017	0.600	72.0	67.0	221.9800
400	0.017	0.600	72.0	66.0	227.4500
410	0.017	0.600	72.0	66.0	232.5000
420	0.017	0.600	72.0	66.0	237.7700
430	0.017	0.600	72.0	66.0	243.0300
440	0.017	0.600	72.0	66.0	248.2800
450	0.017	0.600	72.0	65.0	253.5400
460	0.018	0.600	71.0	65.0	258.7900
470	0.018	0.600	72.0	65.0	264.0600
480	0.018	0.600	72.0	66.0	269.3200
490	0.018	0.600	72.0	65.0	274.5700
500	0.018	0.600	71.0	66.0	279.8200
510	0.018	0.600	71.0	66.0	285.0700

DILUTION TUNNEL LAB DATA TABLE 2 RUN 3A BOOTH 1 FS342-01

520	0.017	0.600	71.0	66.0	290.3300
530	0.017	0.600	71.0	66.0	295.5700
540	0.017	0.600	71.0	66.0	300.7400
550	0.017	0.600	71.0	66.0	305.9300
560	0.017	0.600	70.0	66.0	311.1400
570	0.017	0.600	71.0	66.0	316.4800
580	0.017	0.600	71.0	66.0	321.6200
590	0.017	0.600	71.0	66.0	326.9000
600	0.017	0.600	71.0	66.0	332.1000
610	0.017	0.600	71.0	65.0	337.3500
620	0.017	0.600	70.0	66.0	342.4600
630	0.017	0.600	71.0	66.0	347.6800
640	0.017	0.600	71.0	67.0	353.0300
650	0.017	0.600	72.0	67.0	358.2700
660	0.017	0.600	72.0	68.0	363.3400
670	0.017	0.600	72.0	68.0	368.5900
680	0.017	0.600	72.0	68.0	373.8100
690	0.017	0.600	73.0	68.0	379.0900
700	0.017	0.600	73.0	68.0	384.4200
710	0.017	0.600	73.0	68.0	389.5300
720	0.017	0.600	73.0	68.0	394.8400
730	0.017	0.600	73.0	68.0	400.0200
740	0.017	0.600	73.0	68.0	405.4000
750	0.017	0.600	73.0	68.0	410.6300
760	0.017	0.600	73.0	68.0	415.7200
770	0.017	0.600	73.0	68.0	421.0100
780	0.017	0.600	73.0	68.0	426.1700
790	0.017	0.600	73.0	68.0	431.3900
800	0.017	0.600	73.0	68.0	436.7700
810	0.017	0.600	73.0	68.0	441.8700
820	0.017	0.600	73.0	68.0	447.0800
830	0.017	0.600	72.0	69.0	452.3300
840	0.017	0.600	73.0	69.0	457.4900
849.5					462.5460

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE EMRI WOOD STOVE

RUN NUMBER 3A PROJECT NUMBER PS342-01 SERIAL NUMBER C1106

DATE OF TEST: 11/2/88 STOVE MODEL: BK KING/CAT W07-2

AVERAGE EFFICIENCIES

COMBUSTION= 75.8 %	HEAT TRANS.= 86.5 %	OVERALL= 65.5 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	141.650	(grams/Kg-wood)	112.320	(grams/hour)

TEST DATA

BURN RATE	2.10	(lb/hr-wet)
BURN RATE	0.79	(kg/hr-dry)
BURN RATE	0.95	(kg/hr-wet)
FUEL MOISTURE	16.94	(% Wet basis)
HEAT OUTPUT	10037.58	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	6.34	(DSCF/minute w/HC)
AIR TO FUEL RATIO	16.41	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	268.92	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	153.80	(Degrees F)
AVERAGE STACK MOISTURE	6.28	(% volume-wet w/HC)
AVERAGE CO2	5.16	(% volume-dry w/HC)
AVERAGE O2	15.29	(% volume-dry w/HC)
AVERAGE CO	0.90	(% volume-dry w/HC)

1 -) 86
0 63.20046

07:37:54
11-07-1988

OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 65.8 %

TABLE 2A
TEST DATA LISTING

CLIENT: EMRI RUN NUMBER: 3A DATE OF TEST: 11/2/88

PROJECT NUMBER: PS342-01
FUEL MOISTURE: 20.4
-1.83875E-03
BAROMETRIC PRESSURE (in Hg): 29.48
STOVE WEIGHT (lbs): 328
CHANGE IN STOVE TEMPERATURE(F): 83
FUEL COMPOSITION: %C= 51 %H 7.3
METHOD 5 RESULTS: % MOISTURE= 6.37

MODEL NUMBER: BK KING/CAT W07-2
STACK STATIC PRESSURE(in Hg):

ROOM TEMPERATURE (F): 72
AMBIENT MOISTURE CONTENT (%): 1
FUEL HHV (BTU/lb): 8765
%O= 41
GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:22:23

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34213A.DAT

CLIENT: EMRI | MODEL NO. BK KING

PROJECT NO. PS342-01/3A | RUN NO. 3A

DATE: NOV 02 1988 | TECH: JS/SD

FUEL MOIST (%) 20.40 | CAT NO. W07-2

FUEL CHARGE (LB) 29.8 | COAL BED (LB) 7.0

TEST STARTED: NOV 02 1988 10:57:49 AM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RH(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) REFCAT	(26) INCAT	(27) AFTCAT	(32) ELAE	(33) DRAFT
0	29.8	0.0	69	66	70	233	332	173	0	334	346	792	696	391	62	-.025
10	29.2	0.6	69	66	70	246	343	180	0	305	324	491	769	438	62	-.025
20	29.0	0.2	69	66	70	245	363	172	0	262	270	412	613	372	62	-.030
30	28.9	0.1	69	66	70	225	348	159	0	234	237	373	452	321	62	-.025
40	28.8	0.1	69	66	70	200	328	145	0	212	212	339	341	260	62	-.025
50	28.6	0.2	69	66	70	177	310	133	0	198	195	314	302	219	62	-.025
60	28.5	0.1	69	66	69	159	292	124	0	191	181	322	284	198	62	-.025
70	28.4	0.1	68	65	69	145	273	117	0	182	170	308	268	182	62	-.025
80	28.3	0.1	68	65	69	136	256	112	0	176	161	289	256	171	62	-.025
90	28.2	0.1	68	65	69	129	239	107	0	172	155	290	248	163	62	-.025
100	28.1	0.1	68	65	69	123	222	103	0	168	149	306	246	158	62	-.015
110	27.8	0.3	68	65	68	121	212	101	0	173	149	335	262	162	62	-.015
120	27.5	0.3	67	65	68	121	202	101	0	186	154	368	295	174	62	-.015
130	27.2	0.3	67	65	68	125	197	103	0	196	162	380	331	189	62	-.017
140	26.8	0.4	66	65	67	132	193	105	0	206	169	403	358	205	62	-.017
150	26.4	0.4	66	65	67	139	193	108	0	213	175	418	370	215	62	-.017
160	26.1	0.3	66	65	72	144	194	111	0	215	178	404	372	220	63	-.025
170	25.8	0.3	66	65	68	148	194	112	0	215	179	399	364	220	63	-.020
180	25.5	0.3	66	65	69	149	192	113	0	213	178	392	354	217	64	-.020
190	25.3	0.2	66	65	69	148	188	112	0	211	177	387	345	214	63	-.030
200	25.0	0.3	66	65	69	147	184	111	0	211	176	394	343	211	63	-.025
210	24.7	0.3	66	65	70	145	179	112	0	216	180	401	351	214	64	-.025
220	24.3	0.4	66	65	72	146	176	114	0	222	183	415	351	215	64	-.025
230	24.0	0.3	66	65	72	147	174	115	0	229	186	420	352	215	64	-.025
240	23.7	0.3	66	65	73	148	171	116	0	233	189	426	353	215	64	-.025
250	23.4	0.3	66	65	74	150	168	116	0	238	190	428	356	215	64	-.025
260	23.1	0.3	66	66	75	150	166	116	0	239	191	425	358	216	65	-.025
270	22.8	0.3	66	66	75	151	164	117	0	242	192	423	359	217	65	-.025
280	22.5	0.3	66	66	75	152	162	117	0	250	192	422	359	218	65	-.025
290	22.1	0.4	66	66	75	153	159	117	0	263	194	429	370	223	64	-.025
300	21.5	0.6	66	66	76	157	157	120	0	328	207	511	458	262	65	-.025
310	20.7	0.8	67	66	77	175	156	127	0	329	229	549	524	301	65	-.025
320	20.0	0.7	66	66	76	189	155	132	0	333	238	538	524	311	65	-.025
330	19.4	0.6	66	66	75	197	157	136	0	340	243	537	518	313	65	-.025
340	18.8	0.6	66	66	76	200	158	139	0	340	244	521	499	312	65	-.025
350	18.5	0.3	66	66	77	198	161	139	0	324	241	508	457	295	64	-.025
360	18.2	0.3	66	66	77	192	162	137	0	309	236	488	424	277	65	-.025
370	18.0	0.2	66	66	76	186	162	135	0	300	230	474	405	264	64	-.025
380	17.7	0.3	66	66	77	173	160	129	0	287	218	446	380	245	58	-.025
390	17.6	0.1	66	66	77	172	159	128	0	285	216	446	378	243	57	-.025
400	17.4	0.2	65	66	77	166	157	125	0	277	214	460	374	239	56	-.025
410	17.2	0.2	65	66	77	164	155	124	0	282	215	471	390	242	56	-.025
420	17.0	0.2	65	66	76	164	154	123	0	283	215	481	405	248	56	-.025
430	16.7	0.3	65	65	76	166	153	123	0	282	216	489	414	253	57	-.025
440	16.5	0.2	65	66	76	167	152	124	0	280	218	487	416	253	57	-.025
450	16.2	0.3	65	66	76	170	152	125	0	293	218	486	425	260	57	-.025
460	15.9	0.3	64	65	76	172	152	125	0	292	218	471	423	261	57	-.025
470	15.7	0.2	64	65	74	172	150	125	0	292	215	469	420	257	58	-.025
480	15.4	0.3	64	65	73	173	149	124	0	288	214	460	421	258	58	-.020

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:24:11

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34213A.DAT

CLIENT: EMRI | MODEL NO. BK KING

PROJECT NO. PS342-01/3A | RUN NO. 3A

DATE: NOV 02 1988 | TECH: JS/SD

FUEL MOIST (%) 20.40 | CAT NO. W07-2

FUEL CHARGE (LB) 29.8 | COAL BED (LB) 7.0

TEST STARTED: NOV 02 1988 10:57:49 AM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) DEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
490	15.1	0.3	64	65	73	173	148	124	0	282	212	445	421	258	58	-.020
500	14.7	0.4	64	65	72	173	146	123	0	279	213	446	428	261	59	-.020
510	14.2	0.5	64	65	72	174	145	124	0	292	221	488	441	269	60	-.020
520	13.6	0.6	64	65	72	190	143	128	0	345	237	505	637	437	60	-.020
530	12.6	1.0	64	65	72	260	143	142	0	395	275	589	1364	686	60	-.020
540	11.7	0.9	64	65	72	349	144	164	0	420	302	594	1372	754	61	-.020
550	11.2	0.5	64	65	72	373	146	175	0	393	301	527	1243	656	61	-.020
560	10.9	0.3	64	65	72	354	149	173	0	351	282	478	1049	578	62	-.020
570	10.7	0.2	63	65	72	320	151	167	0	321	263	451	891	494	61	-.020
580	10.6	0.1	63	65	72	288	151	159	0	301	248	426	816	443	60	-.020
590	10.4	0.2	63	65	72	262	150	150	0	279	234	409	770	405	61	-.020
600	10.3	0.1	63	65	72	240	148	144	0	263	223	405	821	410	61	-.025
610	9.9	0.4	63	65	72	239	146	142	0	267	226	457	1066	479	61	-.025
620	9.4	0.5	63	65	71	260	145	145	0	286	238	484	1265	539	61	-.025
630	8.7	0.7	63	65	72	294	144	154	0	309	256	552	1352	620	62	-.030
640	8.0	0.7	63	65	73	337	147	169	0	337	274	591	1459	725	63	-.030
650	7.4	0.6	63	65	73	372	160	179	0	339	285	553	1393	727	63	-.030
660	7.0	0.4	64	64	73	376	173	181	0	324	283	519	1275	689	63	-.030
670	6.7	0.3	64	65	73	357	182	178	0	308	275	506	1093	595	63	-.030
680	6.5	0.2	64	65	74	328	185	172	0	295	265	467	965	518	63	-.030
690	6.4	0.1	65	65	74	301	186	164	0	283	257	446	889	470	63	-.030
700	6.2	0.2	65	65	74	277	185	157	0	271	251	439	854	441	63	-.030
710	6.1	0.1	65	65	74	262	183	151	0	258	249	436	870	424	63	-.030
720	5.9	0.2	65	65	74	256	180	149	0	248	251	445	960	449	63	-.030
730	5.6	0.3	65	65	74	265	176	151	0	251	265	521	1065	506	63	-.030
740	5.2	0.4	65	65	72	280	172	157	0	260	301	577	1105	540	63	-.030
750	4.6	0.6	66	65	72	300	174	166	0	273	334	618	1298	628	64	-.030
760	4.1	0.5	66	65	71	335	180	177	0	284	355	623	1301	675	64	-.030
770	3.8	0.3	66	65	72	345	192	180	0	277	340	514	1133	602	64	-.030
780	3.6	0.2	66	65	72	330	199	175	0	265	327	488	993	531	64	-.030
790	3.5	0.1	66	65	72	302	204	167	0	253	315	472	896	473	64	-.030
800	3.4	0.1	66	65	71	274	208	158	0	240	302	455	794	425	63	-.030
810	3.0	0.4	67	65	71	254	209	156	0	248	323	726	872	477	63	-.030
820	2.0	1.0	67	65	71	276	220	174	0	312	409	929	1109	597	64	-.030
830	1.1	0.9	67	65	71	344	261	209	0	394	468	1150	1190	707	65	-.030
840	0.5	0.6	67	65	72	375	305	230	0	439	487	915	1022	633	65	-.030
850	0.0	0.5	67	65	71	366	338	231	0	438	477	834	943	582	64	-.030
AVG:					72	220	190	141	0	276	243	485	660	368	62	-.025

AVERAGE STARTING SURFACE TEMPERATURE (F): 287
AVERAGE ENDING SURFACE TEMPERATURE (F): 370
TEMPERATURE DIFFERENCE (Te-Ts) 83

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 71.7 AVG. CHANNEL 6: (F) 68.5 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 66.6

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:26:17

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34213A.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/3A — RUN NO. 3A

DATE: NOV 02 1988 — TECH: JS/SD

TEST STARTED: NOV 02 1988 10:57:49 AM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	29.8	10.4	10.8	0.09	109	222	100	4.7		
10	29.2	4.3	16.4	0.09	131	188	100	14.1		
20	29.0	3.4	17.2	0.15	117	163	100	9.0		
30	28.9	2.6	17.8	0.47	110	147	100	7.4		
40	28.8	2.3	18.0	0.78	104	134	100	6.3		
50	28.6	2.5	17.8	0.78	102	124	100	6.0		
60	28.5	2.7	17.8	0.80	100	117	100	5.8		
70	28.4	2.5	18.0	0.81	98	111	100	5.6		
80	28.3	2.6	17.9	0.97	97	107	100	5.5		
90	28.2	2.8	17.7	0.99	95	104	100	5.2		
100	28.1	3.5	17.1	1.18	96	105	100	5.4		
110	27.8	4.4	16.3	1.46	98	109	100	5.7		
120	27.5	5.3	15.5	1.62	103	115	100	6.7		
130	27.2	5.2	15.5	1.55	109	122	100	7.9		
140	26.8	5.1	15.6	1.51	113	129	100	9.0		
150	26.4	4.6	15.9	1.58	111	132	100	8.2		
160	26.1	3.9	16.4	1.67	110	133	100	8.0		
170	25.8	3.5	15.8	1.65	110	112	100	8.6		
180	25.5	3.1	17.3	1.34	109	129	100	7.6		
190	25.3	3.0	17.5	1.30	108	128	100	7.5		
200	25.0	3.5	17.2	1.32	108	127	100	7.5		
210	24.7	3.5	17.2	1.37	112	128	100	8.6		
220	24.3	3.5	17.2	1.35	114	129	100	9.2		
230	24.0	3.5	17.1	1.43	115	129	100	9.7		
240	23.7	2.9	17.4	1.57	116	129	100	9.8		
250	23.4	3.0	17.4	1.56	117	131	100	10.4		
260	23.1	3.0	17.5	1.54	116	130	100	10.1		
270	22.8	2.9	17.4	1.54	99	129	100	5.3		
280	22.5	2.9	17.5	1.36	106	115	100	7.6		
290	22.1	3.2	17.3	1.48	105	124	100	6.8		
300	21.5	5.3	15.5	1.34	121	134	100	11.6		
310	20.7	4.9	16.0	1.33	128	150	100	13.7		
320	20.0	4.3	16.6	1.26	124	154	100	11.8		
330	19.4	4.1	16.7	1.25	123	154	100	11.5		
340	18.8	3.3	17.3	1.27	119	150	100	10.2		
350	18.5	2.6	18.0	0.90	114	144	100	8.7		
360	18.2	2.4	18.3	0.87	110	137	100	7.7		
370	18.0	2.2	18.3	0.90	105	131	100	6.7		
380	17.7	2.1	18.4	1.01	100	126	100	5.5		
390	17.6	2.1	18.3	1.03	100	126	100	5.5		
400	17.4	2.8	17.6	1.34	98	125	100	5.1		
410	17.2	2.8	17.4	1.28	98	126	100	5.1		
420	17.0	2.7	17.6	1.32	97	128	100	4.9		
430	16.7	2.8	17.4	1.45	98	129	100	5.0		
440	16.5	2.8	17.4	1.64	94	134	100	3.9		
450	16.2	3.0	17.4	1.44	102	135	100	5.7		
460	15.9	2.6	17.6	1.44	101	135	100	5.5		
470	15.7	2.6	17.7	1.53	97	140	100	4.3		
480	15.4	2.8	17.5	1.79	99	141	100	4.7		
490	15.1	3.1	17.0	2.12	103	141	100	5.7		
500	14.7	3.4	16.7	2.31	105	142	100	6.3		
510	14.2	4.5	15.9	2.29	110	143	100	7.5		
520	13.6	7.2	13.9	1.14	121	164	100	10.7		
530	12.6	9.8	11.1	0.99	138	205	100	16.8		
540	11.7	9.0	12.4	0.34	135	221	100	14.7		
550	11.2	6.6	14.8	0.20	123	189	100	10.6		
560	10.9	4.7	16.4	0.14	111	171	100	7.0		

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:27:42

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34213A.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/3A — RUN NO. 3A

DATE: NOV 02 1988 — TECH: JS/SD

TEST STARTED: NOV 02 1988 10:57:49 AM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
570	10.7	4.5	16.6	0.16	108	157	100	6.5		
580	10.6	4.1	16.9	0.18	103	148	100	5.5		
590	10.4	3.9	17.1	0.21	102	140	100	5.5		
600	10.3	5.2	15.9	0.46	117	147	100	9.5		
610	9.9	8.0	13.5	0.67	114	165	100	8.1		
620	9.4	9.2	12.2	0.55	119	178	100	9.5		
630	8.7	10.9	10.7	0.41	124	194	100	10.9		
640	8.0	11.7	10.1	0.44	131	208	100	13.4		
650	7.4	9.6	12.0	0.27	129	198	100	13.0		
660	7.0	7.6	13.7	0.17	120	187	100	9.0		
670	6.7	6.7	14.6	0.17	115	178	100	8.0		
680	6.5	6.0	15.1	0.18	111	165	100	7.0		
690	6.4	5.8	15.2	0.20	111	156	100	7.4		
700	6.2	6.0	14.9	0.23	129	151	100	14.2		
710	6.1	6.1	14.8	0.24	102	144	100	5.3		
720	5.9	7.2	13.9	0.35	103	149	100	5.6		
730	5.6	8.9	12.6	0.42	108	161	100	6.3		
740	5.2	9.2	12.1	0.37	117	177	100	8.5		
750	4.6	11.7	10.1	0.40	126	192	100	11.8		
760	4.1	10.1	11.3	0.21	132	192	100	14.5		
770	3.8	6.7	14.4	0.16	128	179	100	12.0		
780	3.6	5.8	15.1	0.16	114	169	100	8.0		
790	3.5	5.3	15.5	0.18	105	154	100	5.9		
800	3.4	4.7	15.8	0.19	99	145	100	4.6		
810	3.0	12.2	9.3	0.59	127	187	100	12.3		
820	2.0	14.7	6.2	0.64	135	252	100	13.8		
830	1.1	14.0	7.1	0.40	125	303	100	10.0		
840	0.5	10.6	10.2	0.24	115	296	100	4.0		
850	0.0	9.6	11.3	0.24	122	276	100	7.3		

AVERAGE CO2(%): 5.26
AVERAGE CO(%): .911
AVERAGE O2(%): 15.5
AVERAGE HE(%): 100

FUEL DATA

OMNI™

Client/Model EMR Navy King KFJ Project # PS342-01

Date 11-2-88 Test Crew JS/SD Run # 3A

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)-12% Actual Reading 12.25

Cal Value(2)-22% Actual Reading 22.00

Piece	Length	Readings			Type
1	8 ft	23.75	22.50	23.25	2x4
2	8 ft	24.00	23.75	23.00	2x4
3	___ ft	___	___	___	___

Length of cut pieces: 6.5 inches

Time (clock) : ___ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 6 4 X 4 6

CALCULATED LOAD WEIGHT: 30.1 ACTUAL LOAD WEIGHT: 0 (2 X 4)

6 (4 x 4)

FUEL PIECE LENGTH: 18.5 29.9 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	19.25	19.00	19.25	4x4
2	22.50	23.00	22.25	4x4
3	21.50	20.75	21.50	4x4
4	19.00	19.75	19.00	4x4
5	20.50	20.25	20.00	4x4
6	19.75	20.00	20.00	4x4
7	___	___	___	___
8	___	___	___	___
9	___	___	___	___
10	___	___	___	___

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 20.40

Time (clock): ___ Room Temp. (F) 60 Initials JS

OMNI-SE.006

OMNI

RUN NOTES

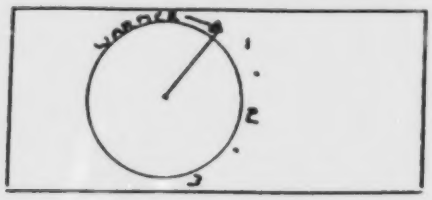
Client/Model EMR Blaze King KFT Project # PS342-01

Date 11-2-88 Test Crew JS/SD Run # 3A

PREBURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:



SECONDARY: Fixed

TERTIARY: Fixed

FAN: High

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY SECDRY TERTRY	FAN SETTNG CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@ 0	Primagair on high					
@ 50					X	
@ 60	Primary air set at 2					
@ 80					X	
@ 130					Y	
@ 150	Primary air set to test setting					
@ 190				X		

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)

START-UP PROCEDURES:

BYPASS: open 1 min 5 sec

FUEL LOADING DOOR: Loaded 1 min 5 sec / closed 1 min 5 sec

PRIMARY AIR: on high for 4 min / 30 sec. then slowly set to test setting

OTHER: Cat. temp at 5 min / 750 / 817 @ 7 min.

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY: SAME AS ABOVE

SECONDARY: fixed

TERTIARY: fixed

FAN: High

OMNI-SE.004

OMNI ENVIRONMENTAL SERVICES Inc.
CURRENT DATE/TIME IS 11-07-1988 / 00:20:22

PROGRAM NAME IS: REP2.EXE
DATA FILE NAME IS: PS34213A.DAT

CLIENT: EMRI | MODEL NO. BK KING

PROJECT NO. PS342-01/3A | RUN NO. 3A

DATE: NOV 02 1988 | TECH: JS/SD

FUEL MOIST (%) 20.40 | CAT NO. W07-2

TOTAL PREBURN TIME (MIN) 210 | LAST PREBURN WT (LB) 7.0

PRE BURN STARTED: NOV 02 1988 07:30:39 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOI	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	32.7	0.0	70	67	73	315	382	211	0	291	321	293	767	477	63	-.040
10	29.9	2.8	70	67	72	291	376	198	0	292	347	711	588	469	62	-.040
20	26.8	3.1	70	67	72	305	431	213	0	344	388	777	1173	33	62	-.045
30	23.6	3.2	70	67	72	373	462	240	0	414	433	891	1365	907	62	-.050
40	21.2	2.4	70	67	72	451	483	277	0	467	505	954	1391	977	62	-.050
50	18.3	2.9	71	67	73	504	495	311	0	528	585	1124	1480	1038	62	-.055
60	16.0	2.3	71	67	74	537	495	338	0	528	574	915	1404	1013	62	-.055
70	15.1	0.9	71	67	74	533	511	326	0	479	512	818	1672	984	61	-.050
80	14.6	0.5	71	67	74	502	485	291	0	411	437	654	1270	820	62	-.040
90	14.2	0.4	71	67	73	457	462	268	0	370	394	587	1639	865	61	-.045
100	13.3	0.9	70	67	73	486	433	251	0	348	366	589	1729	973	61	-.050
110	13.2	0.1	70	67	73	482	413	241	0	342	352	568	1417	856	63	-.035
120	12.8	0.4	70	67	72	430	394	226	0	329	335	548	1176	689	62	-.035
130	12.4	0.4	70	67	72	383	376	213	0	318	328	577	1174	656	62	-.035
140	11.2	1.2	70	67	71	368	368	218	0	332	365	729	1291	701	62	-.045
150	10.2	1.0	70	67	71	442	384	246	0	356	423	744	1467	956	62	-.045
160	10.0	0.2	70	67	71	426	405	247	0	354	398	619	917	622	61	-.035
170	10.0	0.0	70	66	71	344	396	222	0	325	352	553	716	468	62	-.030
180	9.9	0.1	70	66	71	299	379	204	0	305	326	540	669	415	61	-.030
190	9.9	0.0	69	66	71	263	358	186	0	285	303	498	635	373	61	-.025
200	7.3	2.6	69	66	70	240	338	176	0	285	296	707	0	346	62	-.030
210	7.0	0.3	69	66	70	233	332	173	0	334	366	792	0	391	62	-.030

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMR

Model: BK King / WO7-2

Client # : P5342-01

Run #: 3A Batch 1

Prepared By: PK

Date: 11/2/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 102934.0 mg - Tare 102923.2 mg
- Blank (.001 mg/ml) (100 ml acetone) = 10.7 mg

B. Front Filter catch: Filter # H082

Final 1301.8 mg - Tare 566.0 mg = 735.8 mg

C. Back Filter catch: Filter # H081

Final 571.3 mg - Tare 566.0 mg = 5.3 mg

D. Total particulate catch (A + B + C) = 751.8 mg

RUN 4A

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT E.M.R.
MODEL K.E.J.
PROJECT # PS342-01
RUN# 4A
DATE 11-3-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	2.83	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0033	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	27.480	(GRAMS/HOUR)
ADJUSTED EMISSIONS.....	28.47	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	102	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.036	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	107.478	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	72	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	13.08	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	8267.73	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	103.766	(DSCF)
(mn) TOTAL PARTICULATES.....	344.9	(MG)
AVERAGE DELTA H.....	0.6	(INCHES H20)
TOTAL TIME OF TEST.....	224.15	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	E.M.R.
MODEL	K.E.J.
PROJECT #	PS342-01
RUN#	4A
DATE	11-3-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	464.061
GAS METER READING ENDING	571.539
STATIC PRESSURE AVG. PT(IN.H2O)	-0.344
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	344.9
BAR. PRESSURE BEGIN (in. Hg)	29.74
BAR. PRESSURE MIDDLE (in. Hg)	29.73
BAR. PRESSURE ENDING (in. Hg)	29.74
TOTAL TIME OF TEST(MINUTES)	224.15
TEST LOAD FUEL WEIGHT (LBS.)	28
FUEL MOISTURE % (DRY BASIS)	19.93

AVG BAR. PRESSURE (in. Hg)	29.74
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	72
AVG TEMP. METER DEGREES R	532
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.7
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	561.7
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	13.076

DILUTION TUNNEL LAB DATA TABLE 2 RUN 4A SE P5342-01 Booth 1

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.017	0.600	66.0	153.0	464.0610
10	0.018	0.600	67.0	101.0	469.2100
20	0.018	0.600	68.0	100.0	473.3500
30	0.018	0.600	68.0	100.0	475.6100
40	0.018	0.600	69.0	101.0	480.2750
50	0.018	0.600	69.0	102.0	484.4700
60	0.018	0.600	70.0	102.0	488.6900
70	0.019	0.600	71.0	102.0	493.0600
80	0.018	0.600	72.0	102.0	497.7700
90	0.018	0.600	73.0	103.0	502.8000
100	0.018	0.600	73.0	103.0	507.8900
110	0.018	0.600	74.0	102.0	513.1700
120	0.018	0.600	73.0	100.0	518.1300
130	0.018	0.600	73.0	98.0	523.1500
140	0.018	0.600	73.0	97.0	528.4500
150	0.018	0.600	73.0	97.0	533.4400
160	0.018	0.600	73.0	97.0	538.4700
170	0.018	0.600	73.0	97.0	543.5500
180	0.018	0.600	73.0	97.0	548.5800
190	0.018	0.600	73.0	96.0	553.6300
200	0.018	0.600	74.0	96.0	558.7600
210	0.018	0.600	74.0	97.0	563.9900
220	0.018	0.600	75.0	96.0	569.2900
224.25					571.5980

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE EMRI WOOD STOVE

RUN NUMBER 4A PROJECT NUMBER PS342-01 SERIAL NUMBER C1106

DATE OF TEST: 11-3-88 STOVE MODEL: BK KING/CAT W07-2

AVERAGE EFFICIENCIES

COMBUSTION= 79.8 %	HEAT TRANS.= 78.8 %	OVERALL= 62.9 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	143.250	(grams/Kg-wood)	405.890	(grams/hour)

TEST DATA

BURN RATE	7.49	(lb/hr-wet)
BURN RATE	2.83	(kg/hr-dry)
BURN RATE	3.40	(kg/hr-wet)
FUEL MOISTURE	16.62	(% Wet basis)
HEAT OUTPUT	34450.56	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	10.11	(DSCF/minute w/HC)
AIR TO FUEL RATIO	7.21	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	42.12	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	352.75	(Degrees F)
AVERAGE STACK MOISTURE	12.68	(% volume-wet w/HC)
AVERAGE CO2	12.36	(% volume-dry w/HC)
AVERAGE O2	7.06	(% volume-dry w/HC)
AVERAGE CO	2.04	(% volume-dry w/HC)

1 -> 24 07:42:46

0 64.76299 11-07-1988

OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 62.7 %

TABLE 2A
TEST DATA LISTING

CLIENT: EMRI RUN NUMBER: 4A DATE OF TEST: 11-3-88

PROJECT NUMBER: PS342-01
FUEL MOISTURE: 19.93
BAROMETRIC PRESSURE (in Hg): 29.74
STOVE WEIGHT (lbs): 328
CHANGE IN STOVE TEMPERATURE(F): -59
FUEL COMPOSITION: %C= 51 %H 7.3
METHOD 5 RESULTS: % MOISTURE= 12.96

MODEL NUMBER: BK KING/CAT W07-2
STACK STATIC PRESSURE(in Hg):-.0039717
ROOM TEMPERATURE (F): 75
AMBIENT MOISTURE CONTENT (%): 1
FUEL HHV (BTU/lb): 8765
%O= 41
GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 01:08:49

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34214A.DAT

CLIENT: EMRI | MODEL NO. BK KING

PROJECT NO. PS342-01/4A | RUN NO. 4A

DATE: NOV 03 1988 | TECH: JS/SD

FUEL MOIST (%) 19.93 | CAT NO. W07-2

FUEL CHARGE (LB) 29.2 | COAL BED (LB) 6.8

TEST STARTED: NOV 03 1988 11:08:21 AM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RN(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	28.0	0.0	64	62	72	405	502	293	0	568	595	996	968	606	63	-.050
10	24.8	3.2	69	63	72	411	491	282	0	447	488	919	1155	820	62	-.055
20	21.8	3.0	69	63	73	455	483	293	0	443	484	1030	1264	965	63	-.060
30	18.9	2.9	70	63	73	491	476	310	0	460	514	1126	1384	1027	63	-.060
40	15.8	3.1	71	63	73	515	466	324	0	485	540	1175	1472	1053	64	-.060
50	12.5	3.3	73	63	74	534	455	334	0	500	569	1203	1538	1107	64	-.060
60	10.2	2.3	73	65	73	545	447	341	0	522	599	1276	1676	1169	64	-.060
70	8.3	1.9	72	66	73	563	439	351	0	537	630	1391	1659	1172	64	-.060
80	6.7	1.6	72	66	75	578	434	358	0	552	654	1385	1627	1160	64	-.060
90	5.6	1.1	72	66	76	567	432	346	0	563	667	1452	1560	1031	65	-.055
100	4.7	0.9	72	66	76	551	431	341	0	568	676	1324	1460	974	65	-.055
110	4.2	0.5	72	66	76	508	432	330	0	554	656	1159	1136	809	65	-.055
120	3.8	0.4	72	67	76	453	439	304	0	533	628	1053	1032	694	65	-.055
130	3.5	0.3	72	67	76	425	443	292	0	532	615	1046	1000	666	65	-.050
140	3.0	0.5	73	67	76	405	442	280	0	538	607	1051	1016	645	63	-.050
150	2.7	0.3	73	67	75	397	442	272	0	560	584	998	1018	631	63	-.050
160	2.3	0.4	73	67	76	393	442	268	0	556	574	984	1011	629	63	-.045
170	1.9	0.4	73	67	76	392	437	264	0	538	570	992	1029	636	63	-.050
180	1.6	0.3	73	68	76	390	432	261	0	537	565	969	1026	628	63	-.050
190	1.2	0.4	73	68	76	388	424	259	0	524	564	958	1029	637	63	-.050
200	0.9	0.3	74	68	76	385	417	257	0	518	567	951	1040	639	64	-.050
210	0.5	0.4	74	68	76	384	412	257	0	508	560	922	1052	633	63	-.050
220	0.2	0.3	74	69	77	382	407	253	0	498	550	904	1031	624	64	-.050
230	0.0	0.2	74	69	75	378	405	251	0	492	546	898	996	595	63	-.050
AVG:					75	454	443	297	0	522	583	1090	1216	814	64	-.054

AVERAGE STARTING SURFACE TEMPERATURE (F): 473
AVERAGE ENDING SURFACE TEMPERATURE (F): 414
TEMPERATURE DIFFERENCE (Te-Ts) .....-59

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 71.7 AVG. CHANNEL 6: (F) 69.6 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 99

DMI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 01:10:48

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34214A.DAT

CLIENT: EMRI — MODEL NO. BK KING

PROJECT NO. PS342-01/4A — RUN NO. 4A

DATE: NOV 03 1988 — TECH: JS/SD

TEST STARTED: NOV 03 1988 11:08:21 AM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	28.0	10.6	10.6	0.14	120	348	100	3.9		
10	24.8	14.0	3.6	6.82	155	306	100	24.2		
20	21.8	15.0	2.7	6.65	158	345	100	25.7		
30	18.9	15.4	2.3	6.89	160	391	100	26.2		
40	15.8	15.0	2.2	7.77	162	390	100	28.1		
50	12.5	15.2	2.3	7.28	160	404	100	25.9		
60	10.2	16.5	1.9	5.17	160	395	100	26.4		
70	8.3	14.8	4.0	4.33	146	399	100	15.5		
80	6.7	16.9	3.0	1.54	143	408	100	13.5		
90	5.6	16.3	3.9	1.07	145	385	100	15.4		
100	4.7	14.5	5.9	0.38	146	383	100	16.1		
110	4.2	12.0	8.2	0.11	145	380	100	15.6		
120	3.8	10.5	10.4	0.14	137	344	100	11.9		
130	3.5	11.0	9.7	0.13	145	338	100	16.8		
140	3.0	11.5	9.3	0.11	141	339	100	14.4		
150	2.7	11.1	9.7	0.16	141	336	100	14.5		
160	2.3	10.9	10.0	0.17	140	335	100	13.0		
170	1.9	11.3	9.8	0.15	135	333	100	11.2		
180	1.6	10.9	10.1	0.21	138	321	100	13.2		
190	1.2	10.4	10.5	0.25	131	318	100	9.8		
200	0.9	10.6	10.3	0.33	139	321	100	13.8		
210	0.5	10.1	10.9	0.40	126	323	100	7.2		
220	0.2	10.1	10.9	0.35	132	314	100	10.3		
230	0.0	10.0	10.9	0.33	134	310	100	11.5		

AVERAGE CO2(%): 12.7
AVERAGE CO(%): 2.12
AVERAGE O2(%): 7.19
AVERAGE HE(%): 100

FUEL DATA

OMNI™

Client/Model EMR Blazeking KCT Project # PS342-01

Date 11-3-98 Test Crew JS/SD Run # 4A

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)-12% Actual Reading 12.25

Cal Value(2)-22% Actual Reading 22.00

Piece	Length		Readings		Type
1	8 ft	19.75	20.25	19.75	2x4
2	8 ft	21.75	22.00	22.25	2x4
3	___ ft				

Length of cut pieces: 7 inches

Time (clock) : _____ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 0 4 X 4 6

CALCULATED LOAD WEIGHT: 30.1 ACTUAL LOAD WEIGHT: Ø (2 X 4)

28.0 (4 x 4)

FUEL PIECE LENGTH: 19" 28.0 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	19.25	19.50	19.50	4x4
2	20.25	20.00	19.75	4x4
3	19.75	19.75	19.25	4x4
4	19.00	20.25	19.75	4x4
5	21.75	20.50	20.25	4x4
6	20.00	20.25	20.00	4x4
7				
8				
9				
10				

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 19.93

Time (clock): 1000 Room Temp. (F) 60 Initials JS

OMNI-SE.006

OMNI™

RUN NOTES

Client/Model EMR Blaze King KET Project # PS342-01

Date 11-3-88 Test Crew SJ/SD Run # 4A

PREBURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:

FULL HIGH

SECONDARY: Fixed

TERTIARY: Fixed

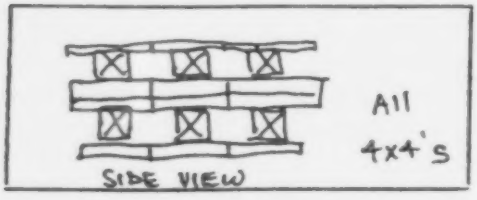
FAN: High

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY	SECDRY	TERTRY	FAN SETTNG CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@40							X	
@70							X	
@90	Turned to 1.5							
@150	Turned to High						X	
@180							X	
@200	Remove Coals					1.5lbs	X	

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)



START-UP PROCEDURES:

BYPASS: open 54 sec.
FUEL LOADING DOOR: Loaded 54 sec. Closed 54 sec.
PRIMARY AIR: FULL HIGH For startup and test
OTHER: Cat temp at 5 min = 1013°F

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:

FULL HIGH

SECONDARY: Fixed

TERTIARY: Fixed

FAN: High

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-07-1988 / 00:52:07

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS342144.DAT

CLIENT: EMRI	MODEL NO. BK KING
PROJECT NO. PS342-01/4A	RUN NO. 4A
DATE: NOV 03 1988	TECH: JS/SD
FUEL MOIST (%) 19.93	CAT NO. W07-2
TOTAL PREBURN TIME (MIN) 216	LAST PREBURN WT (LB) 6.8

PRE BURN STARTED: NOV 03 1988 07:33:21 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOI	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	29.2	0.0	66	63	69	298	255	184	0	373	307	593	759	521	62	-.050
10	26.5	2.7	66	63	69	325	300	201	0	395	315	620	900	650	62	-.050
20	23.9	2.6	65	63	67	389	355	222	0	430	332	759	1288	836	60	-.050
30	22.0	1.9	65	63	68	475	395	248	0	457	352	751	1454	999	59	-.045
40	21.3	0.7	64	63	68	498	396	249	0	433	346	688	1516	900	60	-.045
50	20.0	1.3	64	62	68	498	378	248	0	406	334	619	1678	1060	59	-.045
60	19.5	0.5	64	62	68	531	364	248	0	390	334	644	1736	1078	61	-.040
70	18.8	0.7	64	62	68	526	351	244	0	387	338	642	1696	997	60	-.040
80	17.4	1.4	63	62	68	498	336	245	0	385	351	685	1450	915	60	-.045
90	16.5	0.9	63	62	69	472	327	236	0	374	365	678	1547	853	61	-.045
100	15.6	0.9	63	62	68	465	326	233	0	369	361	651	1442	831	61	-.040
110	15.4	0.2	63	62	69	447	323	228	0	361	352	640	1205	731	61	-.040
120	15.2	0.2	63	62	68	375	315	209	0	338	328	592	866	528	61	-.040
130	15.1	0.1	62	62	68	320	307	192	0	319	310	581	783	449	61	-.040
140	13.9	1.2	63	62	68	300	300	195	0	337	346	832	749	550	61	-.040
150	12.9	1.0	62	62	68	408	358	241	0	428	474	1038	1494	906	61	-.040
160	11.5	1.4	62	62	68	448	397	265	0	487	519	1128	1358	844	61	-.050
170	10.9	0.6	62	62	70	453	432	283	0	531	571	1154	1122	737	62	-.050
180	9.3	1.6	63	62	71	446	475	310	0	602	620	1340	1107	728	62	-.050
190	9.0	0.3	63	62	71	441	484	309	0	596	619	1259	1058	701	62	-.050
200	7.2	1.8	63	62	72	431	492	320	0	584	609	1244	968	654	62	-.050
210	7.0	0.2	63	62	73	415	502	298	0	588	607	1044	1003	629	62	-.050
220	6.8	0.2	64	62	72	405	502	293	0	568	595	996	968	606	63	-.050

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMA Model: ~~DH~~ BNS/4107-2

Client # : RPS342-01 Run #: 4A (Booth 1)

Prepared By: PK Date: 11/3/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 10306.0 mg - Tare 10280.9 mg
- Blank (.001 mg/ml) (150 ml acetone) = 25.0 mg

B. ~~Front~~ Back Filter catch: Filter # H085

Final 567.4 mg - Tare 559.7 mg = 7.7 mg

C. ~~Back~~ Front Filter catch: Filter # H086

Final 766.5 mg - Tare 558.4 mg = 208.1 mg

D. Total particulate catch (A + B + C) Front H090 668.8 − 564.7 = 104.1 = 104.1 mg
344.9

OMNI-AS.003

RUN 1B

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT EMR
MODEL BLAZE KING KING
PROJECT # PS342-1
RUN# 1B
DATE 10-28-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	1.66	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0005	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	3.814	(GRAMS/HOUR)
ADJUSTED EMISSIONS.....	5.53	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	77	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.034	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	204.668	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	75	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	12.39	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	8243.37	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	197.344	(DSCF)
(mn) TOTAL PARTICULATES.....	91.3	(MG)
AVERAGE DELTA H.....	0.6	(INCHES H20)
TOTAL TIME OF TEST.....	399.00	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	EMR
MODEL	BLAZE KING KING
PROJECT #	PS342-1
RUN#	1B
DATE	10-28-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	427.436
GAS METER READING ENDING	632.104
STATIC PRESSURE AVG. PT(IN.H2O)	-0.310
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	91.3
BAR. PRESSURE BEGIN (in. Hg)	29.88
BAR. PRESSURE MIDDLE (in. Hg)	29.88
BAR. PRESSURE ENDING (in. Hg)	29.92
TOTAL TIME OF TEST(MINUTES)	399.00
TEST LOAD FUEL WEIGHT (LBS.)	29.4
FUEL MOISTURE % (DRY BASIS)	20.56

AVG BAR. PRESSURE (in. Hg)	29.89
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	75
AVG TEMP. METER DEGREES R	535
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.9
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	536.5
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	12.387

DILUTION TUNNEL LAB DATA TABLE 2 RUN 18 ~~9E~~ P342-1 Booth 1

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.017	0.600	77.0	95.0	427.4360
10	0.017	0.600	76.0	96.0	432.5000
20	0.017	0.600	75.0	89.0	437.6100
30	0.017	0.600	75.0	86.0	442.8000
40	0.017	0.600	75.0	84.0	448.1400
50	0.017	0.600	75.0	83.0	453.0700
60	0.017	0.600	75.0	83.0	458.2300
70	0.017	0.600	74.0	84.0	463.3200
80	0.017	0.600	74.0	82.0	468.5000
90	0.017	0.600	73.0	81.0	473.6400
100	0.017	0.600	74.0	79.0	478.6400
110	0.017	0.600	74.0	79.0	483.7800
120	0.017	0.600	75.0	80.0	488.8800
130	0.017	0.600	75.0	85.0	494.1300
140	0.017	0.600	74.0	84.0	499.2500
150	0.017	0.600	74.0	82.0	504.2300
160	0.017	0.600	74.0	81.0	509.4300
170	0.017	0.600	74.0	71.0	514.5200
180	0.017	0.600	73.0	78.0	519.6500
190	0.017	0.600	73.0	73.0	524.7200
200	0.017	0.600	73.0	73.0	529.8500
210	0.017	0.600	74.0	74.0	534.9850
220	0.017	0.600	74.0	69.0	540.1000
230	0.017	0.600	74.0	68.0	545.2200
240	0.017	0.600	74.0	68.0	550.3500
250	0.017	0.600	74.0	68.0	555.4800
260	0.017	0.600	74.0	67.0	560.6500
270	0.017	0.600	74.0	69.0	565.7500
280	0.017	0.600	75.0	70.0	570.8800
290	0.017	0.600	76.0	70.0	576.0200
300	0.017	0.600	76.0	71.0	581.1500
310	0.017	0.600	77.0	71.0	586.4200
320	0.017	0.600	77.0	71.0	591.4600
330	0.017	0.600	77.0	71.0	596.5800
340	0.017	0.600	78.0	71.0	601.7300
350	0.017	0.600	78.0	71.0	606.8900
360	0.017	0.600	77.0	71.0	612.0400
370	0.017	0.600	77.0	71.0	617.3000
380	0.017	0.600	78.0	71.0	622.4000
390	0.017	0.600	78.0	71.0	627.4800
399					632.1040

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE E.M.R. WOOD STOVE

RUN NUMBER 1B PROJECT NUMBER PS342-1 SERIAL NUMBER C1106

DATE OF TEST: 10-28-88 STOVE MODEL: B. K. KEJ/CAT W11-2

AVERAGE EFFICIENCIES

COMBUSTION=	81.3 %	HEAT TRANS.=	81.7 %	OVERALL=	66.4 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	66.067	(grams/Kg-wood)	109.894	(grams/hour)

TEST DATA

BURN RATE	4.42	(lb/hr-wet)
BURN RATE	1.66	(kg/hr-dry)
BURN RATE	2.01	(kg/hr-wet)
FUEL MOISTURE	17.05	(% Wet basis)
HEAT OUTPUT	21344.07	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	6.97	(DSCF/minute w/HC)
AIR TO FUEL RATIO	8.49	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	75.49	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	234.51	(Degrees F)
AVERAGE STACK MOISTURE	10.85	(% volume-wet w/HC)
AVERAGE CO2	11.07	(% volume-dry w/HC)
AVERAGE O2	9.36	(% volume-dry w/HC)
AVERAGE CO	0.80	(% volume-dry w/HC)

1 -> 41 01:25:35

0 68.63835 10-31-1988

OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 66.3 %

TABLE 2A
TEST DATA LISTING

LIENT: E.M.K.
0-28-88

RUN NUMBER: 1B DATE OF TEST:

ROJECT NUMBER: PS342-1
UEL MOISTURE: 20.56
AROMETRIC PRESSURE (in Hg): 29.89
TOVE WEIGHT (lbs): 328
HANGE IN STOVE TEMPERATURE(F): -20
UEL COMPOSITION: %C= 51 %H 7.3
ETHOD 5 RESULTS: % MOISTURE= 11.1

MODEL NUMBER: B. F. FEJ/CAT W11-2
STACK STATIC PRESSURE(in Hg):-.002942
ROOM TEMPERATURE (F): 74
AMBIENT MOISTURE CONTENT (%): 1
FUEL HHV (BTU/lb): 8765
%O= 41
GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 00:48:24

PROGRAM NAME IS: REP2.EIE

DATA FILE NAME IS: PS34211B.DAT

CLIENT: E.M.R. | MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/1B | RUN NO. 1B

DATE: OCT 28 1988 | TECH: JS

FUEL MOIST (%) 20.56 | CAT NO. W11-2

FUEL CHARGE (LB) 29.4 | COAL BED (LB) 5.9

TEST STARTED: OCT 28 1988 02:03:32 PM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	29.4	0.0	68	65	76	413	381	275	1195	426	498	1075	1333	949	67	-.050
10	26.7	2.7	70	65	76	486	417	303	0	397	430	752	1462	994	53	-.055
20	25.8	0.9	70	66	76	492	443	284	0	338	364	603	1245	858	54	-.045
30	25.2	0.6	70	66	76	413	435	249	946	297	322	510	836	600	54	-.040
40	25.1	0.1	70	66	76	343	418	221	0	270	294	486	705	493	54	-.040
50	24.7	0.4	70	67	75	287	396	198	0	249	271	533	698	449	55	-.035
60	23.8	0.9	70	67	74	275	382	202	0	270	288	943	1203	671	55	-.040
70	22.0	1.8	70	67	74	381	383	244	1527	336	353	1161	1395	962	56	-.050
80	20.4	1.6	70	67	74	460	389	264	1048	356	367	828	1559	965	56	-.045
90	19.7	0.7	70	67	74	457	383	257	1495	336	344	688	1128	776	56	-.040
100	19.4	0.3	69	67	74	375	362	226	397	302	307	595	793	554	55	-.035
110	19.0	0.4	69	67	73	317	340	204	1235	284	284	595	804	503	55	-.035
120	18.2	0.8	69	67	73	301	329	199	0	297	289	976	1012	590	55	-.040
130	16.2	2.0	69	67	73	408	331	245	0	405	375	1163	1377	978	57	-.050
140	14.1	2.1	69	67	73	480	340	278	1203	452	420	1110	1354	1013	58	-.050
150	12.8	1.3	69	67	73	498	343	282	0	440	419	1027	1482	1011	58	-.05
160	11.9	0.9	69	67	73	498	331	272	1554	400	395	802	1528	948	57	-.045
170	11.3	0.6	70	67	73	474	317	256	205	373	372	757	1506	906	54	-.040
180	10.8	0.5	70	66	73	458	306	245	1457	357	359	720	1468	888	53	-.040
190	10.3	0.5	70	66	73	438	296	233	1536	339	346	690	1364	821	53	-.040
200	9.8	0.5	69	66	72	408	287	227	0	336	360	881	1202	736	53	-.040
210	9.0	0.8	69	66	72	396	293	233	0	356	392	1125	1297	772	53	-.040
220	8.1	0.9	69	66	72	423	310	253	217	393	439	1185	1433	908	53	-.045
230	7.1	1.0	69	66	73	469	326	272	1616	421	468	1097	1421	957	54	-.045
240	6.5	0.6	69	66	73	477	332	270	1263	416	447	894	1508	936	54	-.040
250	6.0	0.5	69	66	73	461	324	259	1285	398	423	821	1456	870	54	-.038
260	5.7	0.3	69	66	73	433	309	243	1188	375	395	764	1324	804	54	-.035
270	5.3	0.4	69	66	73	410	297	231	1445	356	377	739	1335	780	54	-.035
280	4.9	0.4	70	66	74	402	285	228	1542	349	377	936	1406	811	55	-.035
290	4.4	0.5	70	66	75	398	281	231	0	368	406	995	1217	745	55	-.035
300	3.9	0.5	71	67	75	388	293	236	0	392	429	1075	1154	721	55	-.035
310	3.4	0.5	71	67	75	381	315	241	229	411	449	1075	1129	704	56	-.035
320	3.0	0.4	72	67	76	373	333	243	0	414	458	976	1071	665	56	-.0[illegible]
330	2.7	0.3	72	67	76	363	341	240	0	413	453	877	1031	634	56	-.0[illegible]
340	2.4	0.3	72	67	76	351	344	235	0	407	445	862	1008	613	56	-.035
350	2.1	0.3	73	67	76	343	347	232	627	404	445	911	1012	625	56	-.035
360	1.7	0.4	73	68	76	344	349	233	0	422	444	888	1021	636	56	-.035
370	1.3	0.4	74	68	77	358	352	238	0	459	442	959	1069	669	56	-.038
380	0.7	0.6	74	68	77	364	359	242	1551	512	454	1021	998	643	57	-.040
390	0.3	0.4	74	68	77	361	375	243	0	517	461	965	972	622	57	-.035
400	0.0	0.3	75	68	77	339	402	235	1888	490	440	855	942	576	67	-.035
AVG:					74	402	346	244	1159	379	393	876	1201	765	56	-.040

AVERAGE STARTING SURFACE TEMPERATURE (F): 399
AVERAGE ENDING SURFACE TEMPERATURE (F): 379
TEMPERATURE DIFFERENCE (Te-Ts) .....-20

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 75.1 AVG. CHANNEL 6: (F) 73.1 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 76.1

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 01:05:46

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS34211B.DAT

CLIENT: E.M.R. MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/1B RUN NO. 1B

DATE: OCT 28 1988 TECH: JS

TEST STARTED: OCT 28 1988 02:03:32 PM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	29.4	17.3	2.2	5.64	162	299	100	29.9		
10	26.7	16.4	3.9	4.16	154	296	100	23.8		
20	25.8	7.3	13.6	0.09	136	239	100	14.6		
30	25.2	5.5	15.3	0.02	125	207	100	10.3		
40	25.1	5.5	15.3	0.03	119	185	100	9.1		
50	24.7	7.5	13.4	0.15	123	180	100	10.4		
60	23.8	15.6	5.6	1.20	137	227	100	15.5		
70	22.0	17.0	3.4	3.72	143	282	100	17.2		
80	20.4	12.5	9.1	0.16	140	250	100	16.4		
90	19.7	6.1	14.9	0.04	129	222	100	11.9		
100	19.4	4.9	15.9	0.02	118	190	100	8.6		
110	19.0	7.5	13.7	0.06	114	188	100	7.1		
120	18.2	12.7	9.0	0.09	126	213	100	10.7		
130	16.2	18.1	2.5	5.14	143	301	100	16.6		
140	14.1	17.5	3.2	5.60	144	290	100	17.5		
150	12.8	16.0	5.3	3.57	141	265	100	16.5		
160	11.9	12.1	9.5	0.12	144	234	100	19.4		
170	11.3	10.7	10.8	0.08	141	220	100	17.9		
180	10.8	9.8	11.6	0.07	130	213	100	12.5		
190	10.3	8.9	12.5	0.06	135	209	100	15.0		
200	9.8	12.1	9.4	0.09	119	236	100	7.4		
210	9.0	13.5	7.8	0.22	126	252	100	9.6		
220	8.1	14.9	6.0	0.87	131	232	100	12.4		
230	7.1	15.0	5.6	1.68	132	259	100	12.1		
240	6.5	12.5	8.5	0.67	128	226	100	11.0		
250	6.0	10.4	10.5	0.10	135	210	100	14.7		
260	5.7	8.5	12.4	0.05	115	201	100	6.9		
270	5.3	9.1	11.9	0.06	113	189	100	6.8		
280	4.9	11.8	9.3	0.11	112	220	100	5.5		
290	4.4	11.9	9.3	0.09	115	239	100	5.6		
300	3.9	11.8	9.2	0.08	115	244	100	5.6		
310	3.4	11.4	9.4	0.07	135	243	100	14.0		
320	3.0	10.3	10.7	0.06	133	235	100	12.4		
330	2.7	9.6	11.3	0.05	120	228	100	7.9		
340	2.4	9.6	11.2	0.05	106	220	100	3.6		
350	2.1	10.5	10.5	0.08	109	236	100	3.8		
360	1.7	11.1	10.0	0.09	110	243	100	4.1		
370	1.3	11.6	9.4	0.09	114	248	100	5.1		
380	0.7	11.5	8.4	0.05	120	257	100	6.7		
390	0.3	11.1	9.6	0.05	112	245	100	4.5		
400	0.0	10.5	10.3	0.09	110	242	100	4.5		

AVERAGE CO2(%): 11.4
AVERAGE CO(%): .847
AVERAGE O2(%): 9.55
AVERAGE HE(%): 100

OMNI

RUN NOTES

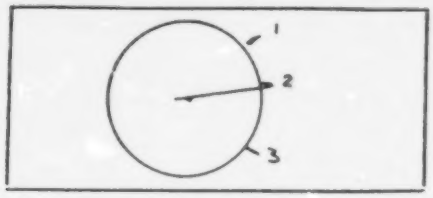
Client/Model E.M.R. / K.E.J. Project # PS342-1

Date 10-28-88 Test Crew SD/JD Run # # 1B

PRE-BURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:



SECONDARY: fixed

TERTIARY: fixed

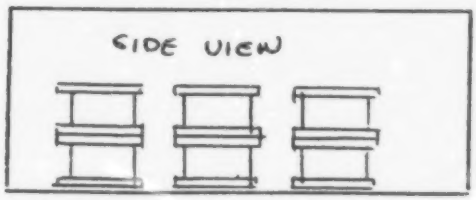
FAN: High

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY SECDRY TERTRY	FAN SETTNG CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@ 11P @ 5D	Primary air set to test setting from high				X X	

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)



START-UP PROCEDURES:

BYPASS: Open to load fuel 1:15
FUEL LOADING DOOR: Loaded in 1:15 / Closed at 1:15
PRIMARY AIR: Full High for 4½ min. Then slowly set down to test setting by 5 min.
OTHER:

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY:

same as above

SECONDARY: fixed

TERTIARY: fixed

FAN: High

OMNI-SE.004

FUEL DATA

OMNI Inc

Client/Model E.M.R. / K.E.T. Project # PS342-1

Date 10-28-86 Test Crew JD/JJ Run # 1B

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)=12% Actual Reading 12.00

Cal Value(2)=22% Actual Reading 22.50

Piece	Length		Readings			Type
1	8 ft	19.5	20.25	19.5		2x4
2	___ ft					
3	___ ft					

Length of cut pieces: _____ inches

Time (clock) : _____ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 Ø 4 X 4 6

CALCULATED LOAD WEIGHT: 301 ACTUAL LOAD WEIGHT: Ø (2 X 4)

294 (4 x 4)

FUEL PIECE LENGTH: 18.5 294 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	19.25	19.25	19.5	4x4's
2	20.5	19.25	20.25	
3	22.75	21.0	22.5	
4	19.5	19.5	19.0	
5	22.5	21.0	21.25	
6	21.5	20.5	21.0	↓
7				
8				
9				
10				

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 20.56

Time (clock): _____ Room Temp. (F) 60 Initials JS

OMNI-SE.006

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 10-31-1988 / 01:04:07

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS342118.DAT

CLIENT: E.M.R.	MODEL NO. BLAZE KING KING
PROJECT NO. PS342-1/1B	RUN NO. 1B
DATE: OCT 28 1988	TECH: JS
FUEL MOIST (%) 20.56	CAT NO. W11-2
TOTAL PREBURN TIME (MIN) 130	LAST PREBURN WT (LB) 6.1

PRE BURN STARTED: OCT 28 1988 11:51:27 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	30.1	0.0	64	63	65	301	191	181	0	272	255	187	653	454	58	-.060
10	26.3	3.8	64	62	65	253	251	180	307	287	301	815	730	455	58	-.045
20	23.7	2.6	63	62	66	272	320	209	0	314	377	974	1254	727	60	-.045
30	21.1	2.6	63	62	67	392	381	265	0	361	464	1054	1446	956	62	-.055
40	17.5	3.6	64	62	69	440	404	290	643	387	514	1012	1464	1022	63	-.055
50	14.7	2.8	64	63	70	496	435	325	0	428	596	1141	1435	1142	64	-.055
60	13.0	1.7	65	63	74	536	440	319	0	419	490	857	1600	999	65	-.055
70	11.2	1.8	65	63	74	533	439	316	0	415	485	845	1596	990	65	-.045
80	10.6	0.6	65	64	74	498	418	289	0	383	444	735	1374	884	65	-.045
90	10.3	0.3	66	64	75	435	395	258	0	347	410	636	1046	695	65	-.035
100	10.0	0.3	66	64	75	378	377	234	900	320	384	597	939	603	66	-.035
110	9.8	0.2	67	65	75	339	360	217	0	303	372	619	963	580	66	-.030
120	8.2	1.6	66	65	75	328	354	241	1339	350	407	1220	983	623	66	-.065
130	6.1	2.1	68	65	76	413	381	275	1195	426	498	1075	1333	949	67	-.065

OMNI ™

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMR Model: King

Client # . F5342-01 Run #: 1B Baseline

Prepared By: PK Date. 10/28/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 10168.0 mg - Tare 10161.6 mg
- Blank (.001 mg/ml) (100 ml acetone) = 6.4 mg

B. Front Filter catch: Filter # H071

Final 646.0 mg - Tare 565.0 mg = 81.0 mg

C. Back Filter catch: Filter # H070

Final 563.5 mg - Tare 559.6 mg = 3.9 mg

D. Total particulate catch (A + B + C) = 91.3 mg

OMNI ENVIRONMENTAL SERVICES, INC.

PS342-01

RUN 2B

EPA METHOD 5G-1 AND 28 RESULTS

CLIENT E.M.R.
MODEL BLAZE KING KING
PROJECT # PS342-1
RUN# 2B
DATE 10-31-88
FILTER HOLDER# B (BOOTH 1)

FINAL

EPA METHOD 5G-1 AND 28 RESULTS

BURN RATE	3.10	(KG/HR DRY)
PARTICULATE CONCENTRATION (DRY-STANDARD)..	0.0006	(GRAMS/DSCF)
PARTICULATE EMISSION RATE.....	5.018	(GRAMS/HOUR)
ADJUSTED EMISSIONS.....	6.94	(GRAMS/HOUR)
TUNNEL TEMPERATURE AVERAGE.....	69	(DEGREES FAHRENHEIT)
AVERAGE DELTA P RUN DATA.....	0.030	(INCHES H20)
(Vm)TOTAL SAMPLE VOLUME (METER CONDITIONS)	112.980	(CUBIC FEET)
AVERAGE GAS METER TEMPERATURE.....	73	(DEGREES FAHRENHEIT)
(vs)AVG. GAS VELOCITY IN DILUTION TUNNEL..	11.57	(FEET/SECOND)
(Qsd)AVG. GAS FLOW RATE IN DILUTION TUNNEL	7810.05	(DSCFH)
(Vmstd)TOTAL SAMPLE VOL. (STD. CONDITIONS)	109.266	(DSCF)
(mn) TOTAL PARTICULATES.....	70.2	(MG)
AVERAGE DELTA H.....	0.6	(INCHES H20)
TOTAL TIME OF TEST.....	219.50	(MINUTES)

DILUTION TUNNEL LAB DATA TABLE 1

LAB DATA:

	*****ENTRY COLUMN*********
CLIENT	E.M.R.
MODEL	BLAZE KING KING
PROJECT #	PS342-1
RUN#	2B
DATE	10-31-88
FILTER HOLDER#	B (BOOTH 1)
GAS METER READING BEGINNING	632.187
GAS METER READING ENDING	745.167
STATIC PRESSURE AVG. PT(IN.H2O)	-0.260
Y=GAS METER CALIB. FACTOR	0.977
WEIGHT OF TOTAL PARTICULATE (MG)	70.2
BAR. PRESSURE BEGIN (in. Hg)	29.92
BAR. PRESSURE MIDDLE (in. Hg)	29.85
BAR. PRESSURE ENDING (in. Hg)	29.82
TOTAL TIME OF TEST(MINUTES)	219.50
TEST LOAD FUEL WEIGHT (LBS.)	30.1
FUEL MOISTURE % (DRY BASIS)	20.32

AVG BAR. PRESSURE (in. Hg)	29.86
MD-MOLECULAR WEIGHT OF GAS DRY	28.950
MS-MOLECULAR WEIGHT OF GAS WET	28.512
AREA OF TUNNEL (SQ. IN.)	0.196
AVG. TEMP. OF METER (degrees F)	73
AVG TEMP. METER DEGREES R	533
AVERAGE DELTA H	0.6000
CP-PITOT TUBE COEFFICIENT	0.990
KP-PITOT TUBE CONSTANT	85.490
PS-ABS. TUNNEL GAS PRESS.(in.Hg)	29.8
STD. ABSOLUTE PRESSURE (in.Hg)	29.92
K1	17.64
ABSOLUTE TUNNEL TEMP. (deg. R)	528.5
BWS-TUNNEL MOISTURE (%)	0.040
STANDARD ABSOLUTE TEMP. (DEG. R)	528
VS-AVG TUNNEL GAS VEL. (ft/sec)	11.570

DILUTION TUNNEL LAB DATA TABLE 2 RUN 2B ~~BE~~ PS 312-1 Booth 1

TIME MINUTES	TUNNEL FLOW DELTA P/2 ENTRY:	ORIFICE DELTA H ENTRY:	METER TEMP. F (AVG) ENTRY:	TUNNEL TEMP. deg F ENTRY:	METER READING ENTRY:
0	0.016	0.600	70.0	70.0	632.1870
10	0.015	0.600	70.0	70.0	637.2700
20	0.015	0.600	70.0	70.0	642.3900
30	0.015	0.600	71.0	69.0	647.4900
40	0.015	0.600	71.0	70.0	652.9000
50	0.015	0.600	72.0	70.0	657.6600
60	0.015	0.600	72.0	68.0	662.8000
70	0.015	0.600	72.0	68.0	667.8500
80	0.015	0.600	73.0	68.0	672.9800
90	0.015	0.600	73.0	68.0	678.1600
100	0.015	0.600	73.0	69.0	683.2900
110	0.015	0.600	73.0	68.0	688.4400
120	0.015	0.600	74.0	69.0	693.6800
130	0.015	0.600	74.0	68.0	698.8400
140	0.015	0.600	74.0	67.0	704.0300
150	0.015	0.600	74.0	68.0	709.0700
160	0.015	0.600	74.0	68.0	714.2600
170	0.015	0.600	75.0	68.0	719.4500
180	0.015	0.600	75.0	68.0	724.6800
190	0.015	0.600	75.0	67.0	730.9300
200	0.015	0.600	75.0	68.0	735.1200
210	0.015	0.600	75.0	68.0	740.3300
219.3					745.1670

TABLE 1

RESULTS OF EFFICIENCY TESTING ON THE E.M.R. WOOD STOVE

RUN NUMBER 2B PROJECT NUMBER PS342-1 SERIAL NUMBER C1106

DATE OF TEST: 10/31/88 STOVE MODEL: BLAZE KING KING

AVERAGE EFFICIENCIES

COMBUSTION=	HEAT TRANS.=	OVERALL=
81.3 %	82.7 %	67.2 %

EMISSIONS

PARTICULATES:	0.000	(grams/Kg-wood)	0.000	(grams/hour)
CARBON MONOXIDE:	112.582	(grams/Kg-wood)	349.204	(grams/hour)

TEST DATA

BURN RATE	8.23	(lb/hr-wet)
BURN RATE	3.10	(kg/hr-dry)
BURN RATE	3.73	(kg/hr-wet)
FUEL MOISTURE	16.89	(% Wet basis)
HEAT OUTPUT	40273.32	(Btu/hr)
FUEL HIGHER HEATING VALUE	8765.00	(Btu/lb-dry)
AVERAGE STACK FLOW RATE	9.67	(DSCF/minute w/HC)
AIR TO FUEL RATIO	6.28	(lb-air/lb-fuel)
AVERAGE EXCESS AIR	21.50	(% Stoichiometric)
AVERAGE STACK TEMPERATURE	310.00	(Degrees F)
AVERAGE STACK MOISTURE	12.68	(% volume-wet w/HC)
AVERAGE CO2	14.62	(% volume-dry w/HC)
AVERAGE O2	4.90	(% volume-dry w/HC)
AVERAGE CO	1.83	(% volume-dry w/HC)

I -> 23 00:32:32

0 69.05669 11-01-1988

OVERALL EFFICIENCY WITHOUT STOVE TEMPERATURE CHANGE= 67.0 %

TABLE 2A
TEST DATA LISTING

CLIENT: E.M.R.
10/31/88

RUN NUMBER: 2B DATE OF TEST:

PROJECT NUMBER: PS342-1
FUEL MOISTURE: 20.32
BAROMETRIC PRESSURE (in Hg): 29.86
STOVE WEIGHT (lbs): 328
CHANGE IN STOVE TEMPERATURE(F): -75
FUEL COMPOSITION: %C= 51 %H 7.3
METHOD 5 RESULTS: % MOISTURE= 13.01

MODEL NUMBER: BLAZE KING KING
STACK STATIC PRESSURE(in Hg):-.0042659
ROOM TEMPERATURE (F): 75
AMBIENT MOISTURE CONTENT (%): 1
FUEL HHV (BTU/lb): 8765
%O= 41
GRAIN LOADING (gr/scf)= 0

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-01-1988 / 00:09:57

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212b.DAT

CLIENT: E.M.R. | MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/2B | RUN NO. 2B

DATE: OCT 31 1988 | TECH: JS/SD/MF

FUEL MOIST (%) 20.32 | CAT NO. W11-2

FUEL CHARGE (LB) 30.1 | COAL BED (LB) 6.6

TEST STARTED: OCT 31 1988 12:06:17 PM

TEST DATA (FORM 1)

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	30.1	0.0	68	69	74	604	501	370	0	615	585	1317	1641	1238	61	-.065
10	27.2	2.9	68	70	75	605	522	372	0	532	518	490	1395	1243	62	-.065
20	24.8	2.4	68	70	75	597	529	356	0	522	498	464	1400	1221	62	-.060
30	22.4	2.4	68	69	74	594	520	352	0	545	515	467	1529	1138	62	-.060
40	20.0	2.4	68	69	74	598	503	360	0	578	552	495	1547	1268	63	-.065
50	17.8	2.2	68	69	74	610	486	366	0	597	577	1307	1635	1201	63	-.060
60	15.7	2.1	68	69	74	609	463	367	0	611	603	1454	1619	1153	64	-.060
70	13.7	2.0	68	69	75	609	444	372	0	606	620	569	1563	1285	64	-.060
80	11.6	2.1	68	70	75	614	435	379	0	609	661	590	1540	1232	64	-.060
90	10.1	1.5	69	70	75	607	436	383	0	611	677	612	1548	1152	64	-.060
100	8.6	1.5	69	70	75	597	435	380	0	606	684	619	1526	1161	65	-.060
110	7.1	1.5	69	70	75	599	436	381	0	601	684	617	1558	1149	65	-.060
120	5.8	1.3	69	70	76	588	445	374	0	602	688	621	1529	1053	65	-.060
130	4.8	1.0	69	70	76	578	446	368	0	591	683	616	1544	994	65	-.060
140	4.0	0.8	69	70	76	548	446	348	0	583	665	602	1496	933	65	-.055
150	3.3	0.7	69	70	76	539	445	343	0	586	649	591	1476	927	65	-.055
160	2.7	0.6	69	70	76	516	443	328	0	596	621	571	1240	866	65	-.055
170	2.2	0.5	68	70	76	486	448	320	0	614	626	572	1179	823	65	-.055
180	1.7	0.5	68	69	76	458	467	315	0	581	639	577	1095	756	64	-.055
190	1.2	0.5	68	69	76	433	484	306	0	574	617	562	1024	701	64	-.050
200	0.9	0.3	68	69	76	414	485	294	0	553	599	550	1016	689	64	-.050
210	0.5	0.4	67	69	76	408	482	290	0	541	601	551	1019	690	64	-.050
220	0.0	0.5	67	68	76	399	479	283	0	538	601	561	1026	691	64	-.050
AVG:					75	548	469	348	0	582	616	668	1398	1025	64	-.058

AVERAGE STARTING SURFACE TEMPERATURE (F): 535
AVERAGE ENDING SURFACE TEMPERATURE (F): 460
TEMPERATURE DIFFERENCE (Te-Ts) .....-75

ALL TEMPERATURES IN F, WEIGHT IN LBS.

AVG. CHANNEL 5: (F) 73 AVG. CHANNEL 6: (F) 68.9 AVG. CHANNEL 8: (F) 0 AVG. CHANNEL 9: (F) 68.4

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-01-1988 / 00:20:46

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: PS342128.DAT

CLIENT: E.M.R.

MODEL NO. BLAZE KING KING

PROJECT NO. PS342-1/2B

RUN NO. 2B

DATE: OCT 31 1988

TECH: JS/SD/MF

TEST STARTED: OCT 31 1988 12:06:17 PM

TEST DATA (FORM 2)

TIME	(2) WT(lb)	(4) CO2(%)	(7) O2(%)	(1) CO(%)	(13) T(WB)	(10) T(DB)	(3) He(%)	(37) H2O(%)	(ACTUAL W/BYPASS) T(WB)	T(DB)
0	30.1	17.8	1.3	5.92	129	384	100	6.3		
10	27.2	17.6	1.5	6.86	159	323	100	26.5		
20	24.8	18.0	1.9	5.04	159	310	100	27.3		
30	22.4	18.1	2.4	3.65	154	317	100	22.9		
40	20.0	18.6	1.9	3.72	155	330	100	23.0		
50	17.8	18.1	2.5	3.09	149	331	100	19.2		
60	15.7	17.3	3.1	2.70	152	324	100	21.2		
70	13.7	18.0	1.8	2.94	148	332	100	18.9		
80	11.6	18.1	2.1	2.07	134	332	100	10.7		
90	10.1	17.4	3.0	1.30	140	325	100	12.0		
100	8.6	17.1	2.3	2.36	145	322	100	17.2		
110	7.1	16.8	2.9	1.71	145	316	100	17.0		
120	5.8	15.5	4.4	1.02	145	316	100	17.4		
130	4.8	14.2	5.9	0.53	139	317	100	13.8		
140	4.0	13.3	6.8	0.54	137	309	100	12.9		
150	3.3	12.9	6.8	0.43	137	301	100	13.1		
160	2.7	12.4	7.4	0.07	132	294	100	10.8		
170	2.2	12.3	7.4	0.06	132	293	100	10.9		
180	1.7	11.5	8.9	0.04	131	284	100	10.7		
190	1.2	11.0	9.6	0.05	129	274	100	10.0		
200	0.9	10.5	10.2	0.06	127	268	100	9.4		
210	0.5	10.6	10.0	0.06	126	265	100	8.8		
220	0.0	10.4	10.1	0.05	123	263	100	7.7		

AVERAGE CO2(%): 15.11
AVERAGE CO(%): 1.925
AVERAGE O2(%): 4.96
AVERAGE HE(%): 100

FUEL DATA

OMNI™

Client/Model E.M.R. / K.E.S. Project # PS342-1

Date 10-31-88 Test Crew SD/JS Run # 2B

FUEL LOAD PREPARED BY JS

FUEL: DOUGLAS-FIR SPECIES, UNTREATED, AIR-DRIED, STANDARD GRADE OR BETTER, DIMENSIONAL LUMBER.

PRE-BURN FUEL

MOISTURE CONTENT (METER -- DRY BASIS)

CALIBRATION: Cal Value(1)=12% Actual Reading 12.25

Cal Value(2)=22% Actual Reading 22.00

Piece	Length	Readings			Type
1	8 ft	21.75	20.25	20.00	2x4
2	8 ft	20.75	20.50	20.50	2x4
3	___ ft				

Length of cut pieces: _____ inches

Time (clock) : _____ Room Temp. (F) 60 Initials JS

TEST FUEL

FUEL TYPE AND AMOUNT: 2 X 4 Ø 4 X 4 6

CALCULATED LOAD WEIGHT: 30.1 ACTUAL LOAD WEIGHT: Ø (2 X 4)

30.1 (4 x 4)

FUEL PIECE LENGTH: 18.5 30.1 Total

MOISTURE CONTENT (METER -- DRY BASIS)

PIECE	READINGS			TYPE
1	19.50	20.25	20.25	4X4
2	21.25	22.00	22.50	4X4
3	19.25	19.00	19.00	4X4
4	19.00	19.25	20.25	4X4
5	21.75	22.25	19.75	4X4
6	19.75	20.50	20.25	4X4
7				
8				
9				
10				

OVERALL TEST FUEL LOAD MOISTURE AVERAGE: 20.32

Time (clock): _____ Room Temp. (F) 60 Initials JS

OMNI

RUN NOTES

Client/Model E.M.R. / K.E.J. Project # P5342-1

Date 10-4-88 Test Crew SD/JJ Run # 2B

PREBURN

DESCRIBE OR SKETCH AIR OR THERMOSTAT SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY: full high

SECONDARY: Fixed

TERTIARY: Fixed

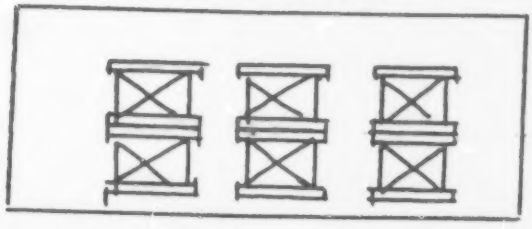
FAN: ~~full~~ high

PRE-BURN SETTINGS AND ACTIVITIES

TIME	AIR (THERMO) CHANGES PRIMARY SECDRY TERTRY	FAN SETTNG CHANGE	ADD FUEL +WT.	REMOVE FUEL -WT.	RAKE COAL	COMMENT
@30	Primary air on high				X	
@45					X	

TEST

TEST FUEL CONFIGURATION SKETCH
(INDICATE VIEW ANGLE)



START-UP PROCEDURES:

BYPASS: TO LOAD 1:30.
FUEL LOADING DOOR: DOOR OPEN TO LOAD 1:30.
PRIMARY AIR: FULL HIGH
OTHER:

DESCRIBE OR SKETCH TEST SETTINGS BELOW:
(SETTINGS MUST BE ACCURATE AND REPRODUCIBLE)

PRIMARY: full high

SECONDARY: Fixed

TERTIARY: Fixed

FAN: High

OMNI ENVIRONMENTAL SERVICES Inc.

CURRENT DATE/TIME IS 11-01-1988 / 00:09:59

PROGRAM NAME IS: REP2.EXE

DATA FILE NAME IS: ps34212b.DAT

CLIENT: E.M.R.	MODEL NO. BLAZE KING KING
PROJECT NO. PS342-1/2B	RUN NO. 2B
DATE: OCT 31 1988	TECH: JS/SD/MF
FUEL MOIST (%) 20.32	CAT NO. W11-2
TOTAL PREBURN TIME (MIN) 64	LAST PREBURN WT (LB) 7.0

PRE BURN STARTED: OCT 31 1988 11:03:38 AM

PRE BURN DATA

TIME	(2) WT	WT DIFF	(12) Tin	(11) Tout	RM(16) TEMP	(19) TOP	(20) BOT	(21) BACK	(22) FBOX	(23) LEFT	(24) RIGHT	(25) BEFCAT	(26) INCAT	(27) AFTCAT	(32) FLUE	(33) DRAFT
0	30.2	0.0	66	61	74	509	483	343	0	555	566	553	966	741	60	-.060
10	25.4	4.8	68	69	76	464	471	296	0	511	455	822	1219	840	61	-.065
20	21.8	3.6	68	69	75	480	481	294	0	530	434	900	1344	961	61	-.065
30	17.4	4.4	68	69	74	514	493	309	0	508	448	920	1353	1109	61	-.065
40	13.6	3.8	67	68	74	547	505	319	0	539	485	1045	1391	1206	62	-.060
50	11.0	2.6	67	69	74	568	505	333	0	585	529	1133	1472	1250	61	-.060
60	7.9	3.1	68	69	74	598	502	362	0	614	578	1224	1520	1267	61	-.060
70	7.0	0.9	68	69	74	604	501	370	0	615	585	1317	1641	1238	61	-.065

FINAL LABORATORY REPORT
DILUTION TUNNEL PARTICULATE CALCULATIONS
METHOD 5G

Rev. 3/87

Client Name: EMR Model: King

Client # : PS342-01 Run #: 2B Booth 1

Prepared By: PK Date: 10/31/88

Checked By: _____

Probe No. : B

A. Particulate from acetone rinse of probe and filter holder assembly:

Final 102293.0 mg - Tare 102282.3 mg
- Blank (.001 mg/ml) (125 ml acetone) = 10.6 mg

B. Front Filter catch: Filter # H074

Final 618.8 mg - Tare 563.4 mg = 55.4 mg

C. Back Filter catch: Filter # H073

Final 570.4 mg - Tare 566.2 mg = 4.2 mg

D. Total particulate catch (A + B + C) = 70.2 mg

Stove Designation: B.K. KING
Stove Condition: Post Test for Catalyst W11-2
PS342-1 Runs 1B + 2B
Pre Test for Catalyst W07-2

Location: OMNI / BOOTH 1
Date: 10-1-88
Operator: MF

Test Condition	Flue Static Pressure (in. H_2O) Target	Actual	High Flow Rotameter (SCFH)	Low Flow Rotameter (SCFH)	Comments
			Pretest / Post Test	Pretest / Post Test	
I. Stove Door Open. Bypass ~~Open~~. closed. Catalyst opening sealed	.01	0.01		3.5 / 2.0	
	.02	0.02		8 / 7.5	
	.03	0.03		12 / 11	
	.04	0.04		15 / 13.5	
	.05 .08	0.05		18 / 17.5	
II Stove Door Open. Bypass Closed.	.01 .10				
	.02				
	.03				
	.04				
	.05				
III Stove Open. Bypass Closed. Catalyst Sealed.	.01				
	.02				
	.03				
	.04				
	.05				

To: Paul Burnett

'87 09/11 16:10 ☎ 919 361 2058 OMNI RTP NC USA 01

Stove Designation: Woodcutters Blaze King / KEJ

Dates System Leak Check Performed: 10/26/88 -

Before Emissions Testing _____ After Emissions Testing _____

Location: OMNI Beaverton, OR.
PS 342 .01 ~07

Operator: JS

Test Condition	Flue Static Pressure (in. H_2O) Target	Actual Pretest	Actual Post test	High Flow Rotameter (SCFH) Pretest	High Flow Rotameter (SCFH) Post test	Low Flow Rotameter (SCFH) Pretest	Low Flow Rotameter (SCFH) Post test	Comments
I. Catalyst blocked, by-pass closed, door ~~open~~, cool primary air valve closed	0.01					<1	<1	
	0.06 .02					6.5	6.5	
	0.10 .03					9.5	8.0	
	0.16 .04					11.5	10.5	
	0.26 .05					14.0	11.5	
II. Catalyst blocked, by-pass open, door closed, primary air valve closed	0.01 .08					12.5	17.0	
	0.06 .10					19.5	19.0	
	0.10							
	0.15							
	0.25							

Appendix 5.3
Standard Operating Procedures
Catalytic Combustor Test

Test Procedure

CAUTION: THIS TEST PROCEDURE USES FLAMMABLE GASES, HIGH PRESSURE CYLINDERS, AND HEATING EQUIPMENT WHICH IF OPERATED IMPROPERLY CAN RESULT IN EXPLOSION AND SERIOUS INJURY. THESE INSTRUCTIONS SHOULD BE READ COMPLETELY BEFORE USING THE BENCH TESTER. ONLY PERSONS THOROUGHLY FAMILIAR WITH THIS TEST METHOD, CYLINDER GASES, AND PRESSURE REGULATORS SHOULD OPERATE THE BENCH TESTER. A FIRE EXTINGUISHER MUST BE KEPT READILY AVAILABLE. THE USE OF A CARBON MONOXIDE LEAK DETECTION DEVICE IS STRONGLY RECOMMENDED.

A. Gas Mixtures

The bench test gas mixture and flow rate to be used in most combustor bench testing is as follows:

Gas	Percent of Mixture
Carbon dioxide (CO_2)	10.0%
Carbon monoxide (CO)	1.5%
Propane	0.6%
Oxygen (O_2)	9.5%
Nitrogen (N_2)	78.4%
Total Mixture	100.0%

If desired, combustors may also be tested at other gas mixtures and/or flow rates by adjusting the rotometer valves to attain a different gas mixture combination. Be sure to check fuel Lower Explosive Level (LEL) values before using different gas fuels or mixtures.

CO_2, CO, and propane are supplied to the bench tester from separate gas cylinders of pure gas for each component. O_2 and N_2 are provided through a mixture of bottled nitrogen gas and clean ambient air in order to reduce cylinder gas consumption. Mixing the gases in the following manner will result in the same gas composition mentioned above:

Gas	Percent of Mixture
Carbon dioxide (CO_2)	10.0%
Carbon monoxide (CO)	1.5%
Propane	0.6%
Nitrogen (N_2)	42.4%
Air	45.5%
Total Mixture	100.0%

Rotometer flow rate settings to achieve this gas mixture can be determined from this desired gas mixture and calibrations of each rotometer. These calculated flow settings are a good starting point, but some additional adjustment of the flow rates may be necessary to achieve the actual desired mixture. It is important to note that indicated rotometer readings are dependent on specific gravity of the gas flowing through the rotometer:

$$Q_{actual} = Q_{indicated} \sqrt{\frac{(sg)_{air}}{(sg)_{sample\ gas}}}$$

where: Q_{actual} = actual flow rate through rotometer

$Q_{indicated}$ = indicated flow rate reading of rotometer

$(sg)_{air}$ = 1.000

$(sg)_{sample\ gas}$ = 1.529 for CO_2

= 0.967 for CO

= 1.554 for propane

= 0.967 for N_2

This correction is required because most widely-available rotometers have scale readings calibrated for air. The correction factor changes the desired rotometer readings for several of the gases, most notably the propane and carbon dioxide. Individual calibration of each rotometer using the actual gas with which it will be used is the preferred way of determining the indicated rotometer readings needed to attain the gas mixture previously mentioned. Generally the rotometers exhibit high accuracy and respond to changes in specific gravity as expected; the following rotometer readings provide the desired gas mixture and flow rate:

Gas	Actual Rate (SCFH)	Rotometer Reading (SCFH)
CO_2	21.0	24.1
CO	4.2	2.1
Propane	1.16	2.2
N_2	88.19	86.
Air	95.45	100.
Total Mixture	210.0	

It should be emphasized that the rotometers are flow devices, and the values obtained are for the gases at standard temperature and pressure. Actual flows will vary slightly depending on atmospheric temperature and pressure (meteorology) and altitude.

Pointer flags may be placed on the rotometers at these settings providing a stable mixture. The use of these pointer flags will make it easier to note any changes in gas flow rates. Care must be taken to exactly duplicate gas flows for each test run. Before starting a combustor bench test, the gas mixture should be stable (as indicated by the gas analyzers sampling before the catalyst). Fine-tune the rotometers to obtain the target gas concentrations on the analyzers.

Record all gas settings, analyzer readings, temperatures and other relevant data on bench tester data sheets (Figure 1). Make sure that all entries are made completely.

B. Testing

The combustor bench test chamber assembly should be set up in a location away from flammable materials with its exhaust gases vented outside. The combustor to be tested should be installed into the appropriate combustor cassette using high temperature gasketing. The combustor cassette is installed into the bench test chamber using nuts and bolts and a flange gasket in good condition. Leak test the combustor with the Leak Testing Device using the following procedures:

1. Make sure the after-catalyst probe ports are capped and that thermocouple fittings are snug.
2. Carefully seal the outlet face of the combustor with duct tape. Seal onto the side of the combustor "can."
3. Attach the flue cap of the leak tester to the collar of the bench tester. Seal with duct tape. Attach the large and small hoses to the large and small nipples.
4. Zero the leak tester Magnehelic. Make sure all flow valves are closed and that the flow selection switch is set for the low range (0 to 20 scfh) flow meter.
5. Turn the blower on and slowly open the fine control valve. Adjust the flow until the Magnehelic reads 0.025 inches water. (This value represents the maximum typical draft experienced by the combustor.)
6. If the flow (leak rate) is less than 10 scfh, record the value. If higher, remove the flue cap and reseal the combustor or reinstall combustor gasketing. Check probe ports and bench tester gaskets. (The 10 scfh leak rate was selected as it represents less than 5 percent gas flow [210 scfh] and is at the practical limits of the system for air tightness.)
7. Record the measured flow rate on the bench tester data sheet.
8. Repeat this procedure after each test when the combustor is cool.

Install thermocouples into the chamber to read temperatures before the catalyst (approximately one inch below), inside the catalyst (middle of cell), and after the catalyst (approximately one inch above). The heater controllers and gas flows should be kept off throughout the equipment set-up.

The gas analyzers to be used should be turned on and warmed up prior to operating the bench tester. Close all five rotometer valves and then adjust each cylinder gas regulator to approximately 10 pounds per square inch. Turn on the air pump.

When initially introducing gases to the bench test chamber, it is important to first introduce a flow of non-flammable carrier gas (air, nitrogen, and carbon dioxide) before injecting the fuel gases of propane and carbon monoxide. This will prevent accumulation of an explosive mixture inside the chamber.

Turn on the air pump and adjust flow to the required flow. Turn on N_2, CO_2, CO and propane tanks and adjust flows. Calibrate CO, CO_2 and O_2 analyzers. Fine-tune gas flows to achieve desired gas concentrations by reading the analyzers. After the CO has been adjusted to 1.5%, calibrate Sun CO analyzer using 100% sample gas. Span the Sun analyzer with span gas, using the propane/hexane concentration factor (0.528 for the OMNI unit). Then add dilution air until a reading of 0.5% is obtained. Finally, adjust the propane injection rate until a value of 1000 ppm is obtained. (This will result in an actual propane concentration of 5600 entering the combustor: 1000 ppm ÷ 0.528 propane-hexane correction factor × 3 dilution factor = 5682 ppm.)

Turn on heaters (Variacs at 100 V, Staco at 83%). Record data at three-minute intervals. Readings must be taken quickly at each time point, and should always be taken in consistent order (CO, O_2, CO_2). Collect data until the inlet gas temperature (TC1) equals 700°F, OR the TC2 rate of increase equals the TC1 rate of increase and propane and CO conversion efficiencies have stabilized.

When the test is done, turn off the heaters. Immediately turn off CO and propane tanks, followed by N_2 and CO_2. Turn air flow up to maximum. Allow to cool until TC1 is less than 150°F before opening. After the bench tester is cool, carefully remove the flue pipe to inspect the combustor assembly. Note any unusual conditions such as combustor damage, discoloration, or misaligned combustor gasketing. Seal the combustor with duct tape (without moving the combustor) and leak test again.

Evaluation of Test Data

The combustor bench test data is evaluated by plotting fuel gas conversion efficiencies versus gas temperature and catalyst activity temperatures versus inlet gas temperatures. Conversion/temperature curves and catalyst temperature/inlet gas temperature curves provide a laboratory means of estimating catalytic activity of a combustor. Percent conversion for each of the fuel gases is determined by the following formulas:

$$CO_{conversion} = \frac{CO_{in} - CO_{out}}{CO_{in}} \times 100\%$$

$$HC_{conversion} = \frac{HC_{in} - HC_{out}}{HC_{in}} \times 100\%$$

Both the CO and propane (HC) conversions can be plotted on the same graph. An additional means of evaluating catalytic activity is by plotting both the in-catalyst and after-catalyst temperatures versus the inlet gas temperature (before-catalyst) to display catalyst "light-off" temperatures.

Figure 1

Data Sheets

CATALYTIC COMBUSTOR BENCH TESTING DATA SHEET

Project Number:

Run Number:

Date:

Combustor I.D. Number:

Make: ☐ Applied Ceramics ☐ Corning ☐ Panasonic ☐ other _____

Model: _____

Thickness: ☐ 1" ☐ 1.5" ☐ 2" ☐ 2.5" ☐ 3"

Dimensions: ☐ round _____ ☐ oval _____ ☐ rectangular _____

Cell size: ☐ 16/in^2 ☐ 20/in^2 ☐ 25/in^2 ☐ other _____

Leak Checks

Pre-test Leak Rate @ 0.025" H_2O _____

Post-test Leak Rate @ 0.025" H_2O _____ Barometric Pressure _____

Gas Calibrations

☐ zeroed

	Analyzer Span (%)		Gas Mixtures		
	Pre-test	Post-test	Target Mix (%)	Rotometer Setting	*Actual Mix (%)
O_2	_____	_____	9.5	_____	_____
N_2	—	_____	(78.0)	_____	—
CO_2	_____	_____	10.0	_____	_____
CO	_____	_____	2.0	_____	_____
Propane	—	—	0.5 (prior to dilution)	_____	—

* record before heaters turned on

HC Analyzer ☐ zeroed ☐ spanned

	Pre-Test	Post-test
% CO (Sun span)	_____	_____
PPM HC (Sun span)	_____	_____

Sample Rotometer _____

Dilution Rotometer _____

Dilution Multiplier _____

Rotometers calibrated (date) _____

Thermocouples/Pyrometer calibrated (date) _____

Notes on Combustor Appearance

Pretest	Post test

Figure 2

Data Sheets

CATALYTIC COMBUSTOR BENCH TESTING DATA SHEET

Project Number: P342-01

Run Number: 1

Date: ~~11/29/88~~ 11/30/88

Combustor I.D. Number: V1

Make: ☐ Applied Ceramics ☒ Corning ☐ Panasonic ☐ other _____

Model: _____

Thickness: ☐ 1" ☐ 1.5" ☒ 2" ☐ 2.5" ☐ 3"

Dimensions: ☐ round _____ ☒ oval _____ ☐ rectangular _____

Cell size: ☒ 16/in² ☐ 20/in² ☐ 25/in² ☐ other _____

Leak Checks

Pre-test Leak Rate @ 0.025" H_2O 3.5 scfH

Post-test Leak Rate @ 0.025" H_2O 5.5 scfH Barometric Pressure 30.49"

Gas Calibrations

☒ zeroed

	Analyzer Span (%) Pre-test	Analyzer Span (%) Post-test	Gas Mixtures Target Mix (%)	Gas Mixtures Rotometer Setting	Gas Mixtures *Actual Mix (%)
O_2	9.9	10.85	9.5		9.5
N_2	—	—	(78.0)		—
CO_2	10.2	9.8	10.0		10.0
CO	1.51	1.51	2.0		1.5
Propane	—	—	0.5 (prior to dilution)		—

HC Analyzer ☒ zeroed ☒ spanned

* record before heaters turned on

	Pre-Test	Post-test
% CO (Sun span)	2.5 750	zeroed @ .03
PPM HC (Sun span)	750	zeroed @ 50

Sample Rotometer _____

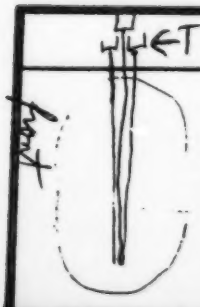
Dilution Rotometer _____

Dilution Multiplier _____

Rotometers calibrated (date) _____

Thermocouples/Pyrometer calibrated (date) _____

Notes on Combustor Appearance

Pretest	Post test
	uniform browning of cat. top and bottom

Start time: 10:22 Run Number: 1 Combustor I.D. Number: V-1

Tested by: JS Date: 11/30/98

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
0	52	51	50		9.5	9.5	10.0	10.0	1.5	1.5	1020/.5	1010/.5		
3	64	52	51		9.5	9.5	10.0	9.9	1.5	1.6	1020/.5	1020/.5		
6	85	58	53		9.5	9.5	10.0	9.9	1.5	1.6	1020/.5	1000/.5		
9	111	69	60		9.5	9.5	9.9	9.9	1.5	1.6	1020/.5	1000/.5		
12	134	82	68		9.5	9.5	9.9	9.9	1.5	1.6	1020/.5	1000/.5		
15	153	95	76		9.5	9.5	9.8	9.9	1.6	1.6	1040/.5	1000/.5		
18	172	112	85		9.5	9.5	9.7	9.8	1.6	1.6	1060/.5	1000/.5		
21	189	135	96		9.5	9.5	9.7	9.8	1.6	1.6	1040/.5	1000/.5		
24	206	167	111		9.5	9.4	9.8	9.9	1.6	1.5	1060/.5	1000/.5		
27	216	198	124		9.5	9.4	9.8	9.9	1.6	1.5	1020/.5	980/.45		
30	233	236	144		9.5	9.4	9.8	9.9	1.6	1.4	1020/.5	1000/.4		
33	250	277	166		9.5	9.4	9.8	9.9	1.6	1.3	1020/.5	1000/.4		
36	272	315	206		9.5	9.3	9.8	10.0	1.5	1.1	1040/.5	1000/.35		
39	293	338	220		9.5	9.2	9.8	10.0	1.5	0.9	1040/.5	1000/.25		
42	317	346	249		9.5	8.9	9.8	10.8	1.5	0.4	1040/.5	1000/.1		
45	340	395	275		9.5	8.8	9.8	10.5	1.4	0.1	1040/.5	1000/.1		
48	357	419	297		9.6	8.7	9.8	11.2	1.4	.05	1040/.5	980/.1		
51	372	439	317		9.6	8.6	9.8	11.2	1.4	.00	1020/.5	980/.1		
54	383	457	337		9.6		9.8		1.4	.00	1020/.5	940/.1		

100,100,83 valid

~~trash~~ 120,120,90 valid

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Start time: 1022 Run Number: 1 Combustor I.D. Number: V-1

Tested by: J.L. Date: 11/30/88

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
57	~~342~~ 340	475	352		9.6	7.3	9.7	12.2	1.35	0.0	1020/.5	560/.1		
60	411	492	372		9.6	6.7	9.7	12.5	1.3	0.0	1020/.5	360/.1		
63	432 ~~392~~	515	392		9.6	6.4	9.7	12.8	1.3	0.0	1020/.5	320/.1		
66	449	544	414		9.6	6.3	9.7	12.8	1.3	0.0	1000/.5	220/.1		
69	473	549	436		9.6	6.3	9.7	12.8	1.2	0.0	1000/.5	180/.1		
72	506	667	460		9.6	6.2	9.6	13.0	1.2	0.0	1000/.4	120/.1		
75	540	728	497		9.6	6.0	9.6	13.0	1.2	0.0	1000/.4	100/.1		
78	565	768	526		9.6	6.1	9.6	13.0	1.2	0.0	1000/.4	100/.1		
81	585	798	560		9.6	6.1	9.6	13.0	1.2	0.0	1000/.4	100/.1		
84	600	814	617		9.6	6.0	9.5	13.0	1.2	0.0	1020/.4	100/.1		
87	616	840	641		9.6	5.9	9.5	13.2	1.2	0.0	1020/.4	80*/.1		
90	627	850	655		9.6	5.9	9.5	13.2	1.2	0.0	1020/.4	80*/.1		
93	641	864	675		9.6	5.9	9.5	13.2	1.2	0.0	1040/.4	80*/.1		
96	650	871	678		9.6	5.9	9.4	13.2	1.2	0.0	1040/.4	80*/.1		
99	656	876	682		9.6	5.9	9.4	13.2	1.2	0.0	1040/.4	80*/.1		
102											/	/		
105											/			
108														
111														

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

*

PS295-05.042

Figure 2

Data Sheets

CATALYTIC COMBUSTOR BENCH TESTING DATA SHEET

Project Number: PS 342-01

Run Number: 3

Date: 12/1/98

Combustor I.D. Number: W07-1

Make: ☐ Applied Ceramics ☐ Corning ☒ Panasonic ☐ other _____

Model: _____

Thickness: ☐ 1" ☐ 1.5" ☒ 2" ☐ 2.5" ☐ 3"

Dimensions: ☐ round _____ ☒ oval _____ ☐ rectangular _____

Cell size: ☒ 16/in² ☐ 20/in² ☐ 25/in² ☐ other _____

Leak Checks

Pre-test Leak Rate @ 0.025" H_2O 6.5

Post-test Leak Rate @ 0.025" H_2O 7.0 Barometric Pressure 30.22"

Gas Calibrations

☐ zeroed

	Analyzer Span (%) Pre-test	Post-test	Gas Mixtures Target Mix (%)	Rotometer Setting	*Actual Mix (%)
O_2	9.9	9.8	9.5	105	9.5
N_2	—	—	(78.0)	95	—
CO_2	10.2	10.4	10.0	25	10.0
CO	1.51	1.45	2.0	3.0	1.5
Propane	—	—	0.5 (prior to dilution)	25	—

* record before heaters turned on

HC Analyzer ☐ zeroed ☐ spanned

	Pre-Test	Post-test
% CO (Sun span)	yes/spanned	yes/spanned
PPM HC (Sun span)	yes/spanned	" "

Sample Rotometer 8

Dilution Rotometer 20

Dilution Multiplier 3

Rotometers calibrated (date) _____

Thermocouples/Pyrometer calibrated (date) _____

Notes on Combustor Appearance

Pretest	Post test
cat grey on top black on bottom 	same as pretest

Start time: 1240 Run Number: 3 Combustor I.D. Number: W07-1

Tested by: JB, JS Date: 12/1/86

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
volts 120, 120, 90%														
0	73	78	78		9.5	9.5	10.0	10.0	1.5	1.7	1000/.5	880/.5		
3	104	76	76		9.5	9.5	10.0	10.0	1.6	1.6	1000/.5	940/.5		
6	156	82	79		9.5	9.5	10.0	10.0	1.6	1.6	960/.5	940/.5		
9	196	94	86		9.5	9.5	10.0	10.0	1.6	1.6	960/.5	900/.5		
12	253	126	108		9.5	9.6	10.0	10.0	1.5	1.6	900/.4	880/.4		
15	297	160	134		9.6	9.6	10.0	10.0	1.5	1.5	880/.4	880/.4		
18	341	201	166		9.6	9.6	10.0	10.0	1.5	1.5	880/.4	840/.4		
21	378	237	197		9.6	9.6	10.0	10.2	1.5	1.5	880/.4	840/.4		
24	413	277	233		9.6	9.6	10.0	10.2	1.4	1.5	880/.4	840/.4		
27	445	312	266		9.6	9.6	10.2	10.2	1.4	1.4	880/.4	840/.4		
30	427	350	305		9.6	9.4	10.2	10.8	1.4	1.1	860/.4	840/.3		
33	442	379	335		9.6	9.3	10.2	11.0	1.4	0.7	860/.4	820/.2		
36	475	433	381		9.6	9.1	10.4	11.6	1.4	.025	860/.4	840/.1		
39	519	500	445		~~9.7~~ 9.7	9.1	10.4	11.8	1.3	.01	860/.4	820/.1		
42	537	542	487		9.6	9.1	10.4	12.0	1.3	0.0	860/.4	820/.0		
45	540	571	525		9.6	9.0	10.4	12.0	1.3	0.0	860/.4	820/.0		
48	563	596	549		9.7	9.0	10.4	12.0	1.3	0.0	860/.4	820/.0		
51	609	615	566		9.7	9.1	10.4	12.0	1.3	0	860/.4	810/0		
54	625	634	582		9.7	9.1	10.4	12.0	1.3	0.0	860/.4	820/0		

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Start time: 12:40 Run Number: 3 Combustor I.D. Number: W07-1

Tested by: C.B., D.S Date: 12/1/88

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
57	633	642	588		9.7	9.1	10.4	12.0	1.3	0.0	860/.3	800/0		
60	640	648	594		9.7	9.1	10.4	12.0	1.3	0.0	860/.3	800/0		
63	646	654	598		9.7	9.1	10.4	12.0	1.3	0.0	860/.3	800/0		
66	653	660	603		9.7	9.1	10.4	12.0	1.3	0.0	860/.3	800/0		
69	660	665	608		9.7	9.1	10.4	12.0	1.3	0.0	860/.3	810/0		
72	670	668	610		9.7	9.1	10.3	11.8	1.3	0.0	860/.3	810/0		
75	679	672	614		9.8	9.2	10.4	12.0	1.3	0.0	860/.3	810/0		
78	687	672	617		9.8	9.2	10.6	12.0	1.2	0.0	860/.3	810/0		
81	691	678	619		9.8	9.2	10.4	12.0	1.2	0.0	860/.3	810/0		
84	693	680	620		9.8	9.2	10.4	12.0	1.3	0.0	860/.3	810/0		
87	700	682	622		9.8	9.2	10.4	12.0	1.3	0.0	860/.3	810/0		
90														
93														
96														
99														
102														
105														
108														
111														

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Figure 2

Data Sheets

CATALYTIC COMBUSTOR BENCH TESTING DATA SHEET

Project Number: PS342-1

Run Number: 2

Date: ~~4/20/88~~ 12/1/88

Combustor I.D. Number: W07-2

Make: ☐ Applied Ceramics ☒ Corning ☐ Panasonic ☐ other _____

Model: _____

Thickness: ☐ 1" ☐ 1.5" ☒ 2" ☐ 2.5" ☐ 3"

Dimensions: ☐ round _____ ☒ oval _____ ☐ rectangular _____

Cell size: ☒ 16/in² ☐ 20/in² ☐ 25/in² ☐ other _____

Leak Checks

Pre-test Leak Rate @ 0.025" H_2O 6.5

Post-test Leak Rate @ 0.025" H_2O 7.0 Barometric Pressure 30.22"

Gas Calibrations

☐ zeroed	Analyzer Span (%)		Gas Mixtures		
	Pre-test	Post-test	Target Mix (%)	Rotometer Setting	*Actual Mix (%)
O_2	9.9	10.2	9.5 air	105	9.5
N_2	—	—	(78.0)	95	—
CO_2	10.2	10.2	10.0	25	10.0
CO	1.51	1.45	2.0	3.0	1.5
Propane	—	—	0.5 (prior to dilution)	25	—

* record before heaters turned on

HC Analyzer ☐ zeroed ☐ spanned

	Pre-Test	Post-test
% CO (Sun span)	zeroed - spanned	zeroed - spanned
PPM HC (Sun span)	750	620

Sample Rotometer 8

Dilution Rotometer 20

Dilution Multiplier 3

Rotometers calibrated (date) _____

Thermocouples/Pyrometer calibrated (date) _____

Notes on Combustor Appearance

Pretest	Post test
new gasket installed btw. cat holder plate and heater 4 TC's	same as pre test grey with some flaking

Start time: 0642 Run Number: 2 Combustor I.D. Number: W07-2

Tested by: JG Date: ~~11/30/88~~ 12/1/88

Volts 120, 120, 90

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
0	51	51	51		9.5		10.0		1.5		1000/.5			
3	66	53	52		9.5	9.1	10.0	9.8	1.5	1.7	1000/.5	980/.45		
6	109	66	56		9.5	9.5	10.0	10.0	1.5	1.7	1000/.5	940/.45		
9	136	81	64		9.5	9.5	10.0	10.0	1.5	1.7	1000/.5	920/.45		
12	155	95	73		9.5	9.5	10.0	9.9	1.5	1.7	1000/.5	880/.45		
15	195	130	99		9.5	9.5	10.0	9.8	1.5	1.6	980/.45	860/.4		
18	221	158	123		9.5	9.5	9.9	9.8	1.5	1.6	960/.45	840/.4		
21	244	183	143		9.5	9.5	9.9	9.8	1.5	1.7	940/.45	860/.4		
24	260	205	166		9.5	9.5	9.9	9.8	1.5	1.7	960/.45	860/.4		
27	276	225	184		9.5	9.6	9.9	9.8	1.4	1.5	980/.5	860/.4		
30	290	243	202		9.5	9.5	9.8	9.8	1.4	1.5	960/.45	840/.4		
33	300	257	216		9.6	9.5	9.8	9.8	1.4	1.5	940/.5	840/.4		
36	312	273	233		9.6	9.5	9.8	9.8	1.4	1.5	920/.5	840/.4		
39	319	284	245		9.6	9.6	9.8	9.8	1.4	1.5	920/.5	840/.4		
42	326	293	255		9.6	9.6	9.8	9.8	1.4	1.5	920/.5	840/.4		
45	331	300	261		9.6	9.6	9.8	9.6	1.4	1.5	900/.45	860/.4		
48	336	308	270		9.6	9.6	9.8	9.6	1.4	1.5	900/.45	860/.4		
51	343	316	279		9.6	9.6	9.8	9.6	1.3	1.4	900/.4	860/.4		
54	347	322	284		9.6	9.6	9.8	9.6	1.3	1.4	900/.4	860/.4		

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Start time: 0842 Run Number: 2 Combustor I.D. Number: W07-2

Tested by: JB Date: 12/1/88

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
cont. @ Volts → 120,120,90% 57	352	328	289		9.6	9.6	9.8	9.6	1.3	1.4	900/.4	840/.4		
60	355	332	295		9.6	9.6	9.7	9.6	1.3	1.4	900/.45	840/.4		
63	358	337	299		9.6	9.6	9.6	9.6	1.4	1.4	900/.45	840/.4		
Volts → 140,140,100% 66	362	341	303		9.6	9.6	9.6	9.6	1.4	1.4	900/.4	840/.4		
69	369	345	306		9.6	9.6	9.6	9.6	1.3	1.4	900/.4	840/.4		
72	375	348	308		9.6	9.6	9.6	9.6	1.3	1.4	900/.4	840/.4		
possible prob. with heaters → 75	345	354	312		9.6	9.6	9.6	9.6	1.3	1.4	900/.4	840/.4		
none found 78	255	363	319		9.6	9.6	9.6	9.6	1.2	1.4	900/.4	840/.4		
81	269	371	323		9.6	9.6	9.6	9.6	1.3	1.3	860/.4	800/.4		
84	286	380	328		9.6	9.6	9.6	9.8	1.3	1.2	840/.4	800/.35		
87	331	397	339		9.6	9.5	9.6	10.0	1.3	1.0	840/.4	780/.3		
90	414	437	363		9.6	9.5	9.6	10.0	1.3	.9	820/.4	780/.3		
93	546	502	401		9.6	9.4	9.6	10.0	1.2	0.8	800/.4	760/.3		
96	577	554	439		9.6	9.3	9.6	10.4	1.2	0.7	900/.4	740/.2		
99	597	587	466		9.6	9.3	9.6	10.4	1.2	0.5	820/.4	760/.2		
102	620	620	492		9.6	9.3	9.6	10.6	1.1	0.3	800/.4	760/.1		
105	642	650	520		9.6	9.1	9.8	10.8	1.1	0.1	820/.4	760/.1		
108	660	674	539		9.6	9.1	9.6	11.0	1.1	0.0	820/.4	780/.05		
~~50~~ 111	676	696	552		9.6	9.1	9.6	11.0	1.1	0.0	820/.4	760/.0		

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Start time: 0842 Run Number: 2 Combustor I.D. Number: W07-2

Tested by: JB Date: 12/1/88

cont @ 40, 140, 100%

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
114	690	713	566		9.6	9.1	9.7	11.0	1.1	0.0	800/.4	760/.0		
117	700	727	575		9.6	9.1	9.8	11.0	1.1	0.0	800/.4	760/.0		
120	706	736	583		9.6	9.1	9.8	11.0	1.1	0.0	800/.4	760/.0		
123														
126														
129														

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____

Figure 2

Data Sheets

CATALYTIC COMBUSTOR BENCH TESTING DATA SHEET

Project Number: PS 342-1

Run Number: 4

Date: 12/1/88

Combustor I.D. Number: WO-11-1

Make: ☐ Applied Ceramics ☐ Corning ☒ Panasonic ☐ other _____

Model: _____

Thickness: ☐ 1" ☐ 1.5" ☒ 2" ☐ 2.5" ☐ 3"

Dimensions: ☐ round _____ ☒ oval _____ ☐ rectangular _____

Cell size: ☒ 16/in² ☐ 20/in² ☐ 25/in² ☐ other _____

Leak Checks

Pre-test Leak Rate @ 0.025" H_2O 7.0

Post-test Leak Rate @ 0.025" H_2O 7.0 Barometric Pressure 30.22"

Gas Calibrations

☐ zeroed

	Analyzer Span (%)		Gas Mixtures		
	Pre-test	Post-test	Target Mix (%)	Rotometer Setting	*Actual Mix (%)
O_2	9.9	10.0	9.5	105	9.5
N_2	—	—	(78.0)	95	—
CO_2	10.2	10.2	10.0	25	10.0
CO	1.51	1.51	2.0	3.0	1.5
Propane	—	—	0.5 (prior to dilution)	25	—

* record before heaters turned on

HC Analyzer ☐ zeroed ☐ spanned

	Pre-Test	Post-test
% CO (Sun span)	zeroed spanned	"
PPM HC (Sun span)	"	"

Sample Rotometer 4

Dilution Rotometer 20

Dilution Multiplier 3

Rotometers calibrated (date) _____ Thermocouples/Pyrometer calibrated (date) _____

Notes on Combustor Appearance

Pretest	Post test
TC's as in run 3 cut grey on top black on bottom	as pretest

Start time: 1535 Run Number: 4 Combustor I.D. Number: WO11-1

Tested by: JB Date: 12/1/88

Volts 120, 90%

Elapsed Time (min)	Temperatures (°F)				Gases (%)									
					O_2		CO_2		CO		Propane/CO			
											Measured		Corrected	
	TC1	TC2	TC3	TC4	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
0	102	96	90		9.5	9.6	10.0	10.0	1.5	1.5	1000/.5	940/.5		
3	129	99	95		9.5	9.6	10.0	10.0	1.6	1.6	920/.5	900/.5		
6	180	106	99		9.6	9.6	10.0	10.0	1.6	1.5	940/.5	900/.4		
9	224	118	104		9.6	9.6	10.0	10.0	1.6	1.5	920/.5	900/.4		
12	281	148	120		9.6	9.6	10.0	10.0	1.6	1.5	900/.5	880/.4		
15	338	194	145		9.6	9.6	10.0	10.0	1.6	1.5	900/.5	880/.4		
18	356	210	155		9.6	9.6	10.0	10.0	1.6	1.5	900/.5	880/.4		
21	400	256	184		9.6	9.6	10.0	10.2	1.6	1.4	900/.5	860/.4		
24	433	293	208		9.6	9.5	10.0	10.4	1.5	1.2	900/.5	860/.3		
27	438	341	247		9.6	9.4	10.2	10.8	1.5	0.9	900/.5	860/.3		
30	499	413	286		9.6	9.4	10.2	11.2	1.5	0.5	900/.5	860/.2		
33	528	490	338		9.6	9.2	10.2	11.4	1.4	0.3	900/.5	860/.1		
36	557	550	407		9.6	9.2	10.2	11.8	1.4	0.2	900/.5	860/.1		
39	576	583	460		9.6	9.1	10.2	11.8	1.4	0.1	900/.4	860/.1		
42	593	610	501		9.7	9.1	10.2	11.8	1.4	0.1	900/.4	860/.1		
45	606	627	517		9.7	9.1	10.2	11.8	1.4	0.1	900/.4	860/.1		
48	622	643	528		9.7	9.1	10.2	11.8	1.4	0.1	900/.4	860/.0		
51	632	653	535		9.7	9.1	10.2	11.8	1.4	0.1	900/.4	860/.0		
54	643	664	543		9.7	9.2	10.2	11.8	1.3	0.1	900/.4	860/.0		

TC1 – pre-cat TC2 – in cat TC3 – post-cat TC4 _____